Start-ups may get funding help from Congress
PAGE 55

Far East is best bet for connector makers
PAGE 79

New tools for taming the computer network
PAGE 71

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE NOVEMBER 4, 1991

INTERNATIONAL REPORT

- Where's the recession headed next? PAGE 29
- Why cost of capital still hurts the U.S. PAGE 40
- Which company topped our international list PAGE 68

Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE
VOLUME 17, NUMBER 21
NOVEMBER 4, 1991

Cover illustration by Meryl Sklut

COVER STORY

29 **Where's the recession heading next?**

The 1990-91 recession seems to be bouncing all over the globe. Everyone will be left a little bruised and battered before it's finished. Our predictions:

- Uninspired recovery for the U.S.
- Japan next in line for the recession
- Western Europe stuck in a slump
- Pacific Rim: bright spot for electronics

UPFRONT

Business Trends

11 PC card standard spells opportunity for computer makers; Sun's Solaris turns up heat on ACE consortium; Higher security for portable computers; Silicon Graphics takes a 3-D gamble; Telecom giants unite for managed networks; IBM readies OS/2 endrun around Microsoft; Software industry zeros in on pirates

Companies to watch

21 Intellon sends data over power lines; Gyration's mini-gyros create talented mice; AG Group offers network management software for the Macintosh

TEMPERANCE.
STRENGTH.
VIII

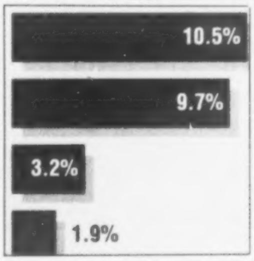
PAGE 11 Trying to tell the future for PC cards and devices that will use them

Business Barometer

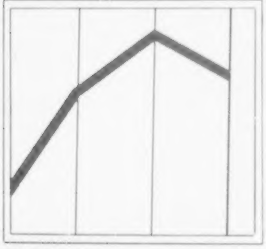
25 **Computers**
How investment drives computers

26 **Leading Indicator**
Summertime blues hit Leading Indicator

PAGE 40 George Hatsopoulos, chairman of Thermo Electron Corp., explains how cost of capital still affects high tech



PAGE 71 Rating the important issues in the LANs



PAGE 79 European connector growth to peak in 1993

FEATURES

SPECIAL REPORT

30 **Regional Outlook/U.S., Japan, Western Europe, Pacific Rim**
The recession that won't go away makes for tough sledding around the world. Prepare for economic doldrums at home, a modest downturn in Japan, and general sluggishness in Europe. So where's the good news? Check out the Pacific Rim

40 **Cost of capital is still a threat to high tech**
Don't be lulled by falling U.S. interest rates in recent years, warns one expert. The gap between U.S. and Japanese price/earnings ratios still puts American companies at a disadvantage

49 **Where to look for cheap bucks**
Stingy banks and timid investors have created a Darwinian investment landscape. Here's how Data General, TI, and a few other creative companies have coped with the capital crunch

55 **Help at last for the beleaguered start-up**
With the wild and crazy days of venture capital long gone, Congress is set to mull big tax breaks for investors who are willing to wait for results

58 **The ELECTRONIC BUSINESS International 100**
Revenues by the world's top electronics companies rose 11% last year, with most of the growth logged in Japan. Here's a look at the top five

Listing of the ELECTRONIC BUSINESS top 100 international electronics companies

71 **The hot WAN manager market attracts a crowd**
Even mighty Microsoft complains of a shortage of network management tools—"the most dynamic area in networking today," by one account. More than 100 vendors are aligning themselves to play in a market that could top $2 billion by 1995

79 **Time's running out for U.S. connector makers**
Lousy demand and a crowded marketplace have made price lists "good only for drawing pictures on," grumbles one vendor. For globally positioned companies and niche suppliers, the biggest growth opportunities lie in Japan and the Pacific Rim

DEPARTMENTS

Inside Business

7 Memorial tribute to Cahners chairman Ronald Segel

My View

89 The vision. And the disconnect

Company Index

92 Companies covered in this issue

Advertiser Index

94 Advertisers covered in this issue

Viewpoint

96 Whose world is it anyway?

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editors: David Webb
Assistant Editors: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Nancy Rutter (San Francisco), Paula Doe (Seattle), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), Xiong Xiaoge, John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100.
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Memorial tribute to Cahners chairman Ronald Segel

THIS SPACE is usually reserved for previewing the important articles you'll find inside ELECTRONIC BUSINESS, but I would like instead to take you inside Cahners Publishing Co. for a moment to share with you our sad loss at the recent death of Ronald Segel, chairman and chief executive of Cahners Publishing and deputy chief executive of the parent company, Reed International plc. Ron died on August 30, at the age of 56, after a year's bout with cancer.

When Ron joined Cahners in 1971 as vice president of finance, we were a trade magazine company with annual revenue of $50 million. Today, after 20 years in which he rose to become president and chief operating officer and ultimately chairman, Cahners is the core of a $1.3 billion communications company.

Cahners Magazine Co., with 84 publications, is now the leading business-to-business publisher in the United States and a growing force in consumer publishing. Our sister exhibit company has become the world's leading organizer of trade shows and exhibitions.

That is a performance in which any business leader could take justifiable pride. Ron Segel's fingerprints can be found on every element on it. His vision and rare judgment will ensure that we continue to grow as a company by enhancing our value to our readers and advertisers.

Ron was a native Bostonian who was a proud graduate of Harvard and Harvard Business School. He was a quiet and private man who spoke most eloquently through his vision for Cahners, his integrity, and his dedication to our people and to those—like you—we serve.

We at Cahners will miss him, and we will honor his memory by our commitment to a climate of excellence in publishing, the founding goal of Norman Cahners that was cherished and nurtured by Ron Segel for 20 years.

—John Russell, editor

ELECTRONIC BUSINESS* (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS* is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS*, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS* copyright 1991 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changos are indicated, single copies are available for $15.00 (USA, Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

BPA ABP

STANDARDS

What future is in the PC cards?

BETTER KNOWN for endlessly haggling over standards, computer vendors have endorsed a single PC card interface specification that experts say will change the look, weight, and power requirements of portable PCs.

In addition to spelling "opportunity" for PC manufacturers, the cards and their applications will require new kinds of components, interconnection, and packaging technology from their suppliers. Devices that use PC cards could amount to some 22 million units by 1995.

By late September, more than 150 electronics industry vendors jumped on the PC Memory Cards International Association (PCMCIA) bandwagon, endorsing form factor, input/output, execution software, and power specs. To what extent they'll design to that spec is yet unclear.

The new cards can contain specialized microcontrollers, coprocessors, DRAM memory or cache memory, disk-drive-like flash EPROM storage, modems, faxes, LAN adapters, and combinations of the above.

Standards-backers now include Hewlett-Packard, IBM, Intel, Zenith Data Systems, Poqet Computer, and even Polaroid, which is considering the card as a sort of reuseable "film" for digital cameras. That's a pretty impressive bunch so far.

The size of a thick credit card, PC cards are lightweight, durable, and power-efficient, and they are interchangeable with other PCMCIA socket-equipped PCs. Because of their size and versatility, PC cards will catalyze hardware downsizing, says Randy Battat, VP for portable computing at Apple.

Sun Disk, for one, packs eight partitionable flash EPROM chips into a single card to achieve 10 Mbytes of capacity. The product is virtually indestructible compared with a disk drive. SunDisk's proprietary EPROMs have 512-byte erasable partitions, as do magnetic disk drives. Intel's comparable Flashcard requires erasure of an entire chip except for one portion designated as a "boot block" for non-rewriteable code.

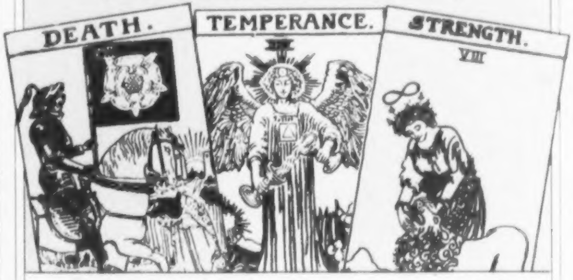
Intel, however, currently is the only company offering a modem-in-a-card, a 2400-baud, 2.5-inch form factor device that supports the Hayes AT command set and just about any PC communications software. Companies such as 3Com are expected to produce LAN adapter cards for portable PCs. So-called "smart cards" and microprocessor-embedded cards for printers, faxes, and scanning equipment are also expected.

The cards will be pricey, at least until volumes reach millions of units. Storage cards, for example, are expensive—about $75 per Mbyte is SunDisk's initial volume price point, compared with about $4 per Mbyte for disk drives. Vendors expect card prices to drop below $50 per Mbyte next year and continue down each year as production volumes jump.

—By David Webb in San Jose

Memory cards mean growth for OEMs

Forecast for devices that will use memory cards*
(Worldwide shipments, millions of units)



	Pessimistic	Likely	Optimistic
1993	2.6	12.5	19
1995	3.9	17.6	22

*Varying models based on the rate of penetration of high-functional vs. low functional PC cards

Worldwide PC card* shipments

(millions of units)

DEATH.
STRENGTH.
VIII

	Pessimistic	Optimistic
1993	52	87
1995	105	268

*Includes LAN adapters, memory cards, disk-drive emulation cards, modems, and faxes

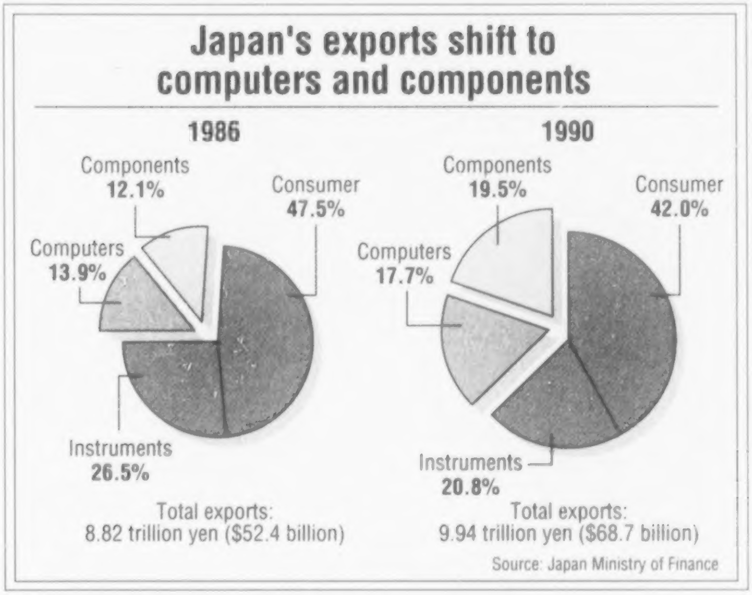
Source: SRI International

OPERATING SYSTEMS

Sun's Solar(is) flare stirs up the PC market cauldron

SUN MICROSYSTEMS' shrink-wrapped Unix strategy may not be a direct response to the Advanced Computing Environment (ACE) initiative, but it definitely turns up the heat on the consortium to get ACE-based products out the door. Sun's Solaris 2.0 is a System V.4-compliant version of the original Sun Unix operating system and is designed to

TRADE



Source: Japan Ministry of Finance

Japan exported $68.7 billion worth of electronics products last year. The trend since 1986 shows computers and components accounting for a greater and greater share of Japan's exports. In fact, despite declining prices, Japan's exports of computers grew 13.6% (valued in yen) last year. Consumer electronics grew only 10.2%, instruments rose 7.7%, and components exports fell 0.8% as memory device prices tumbled. Consumer electronics is not expected to fuel Japan's export growth in the future; computers are clearly expected to pick up the slack.

—Elizabeth B. Baatz

ered "ACE-only." So far, Mips Computer, The Santa Cruz Operation, and other ACE supporters haven't disclosed intentions to license GL.

—By David Webb in San Jose

INTERNATIONAL

Managed network venture finally unites telecom giants

POTENTIAL PROFITS from managed networks—a $2.8 billion global market—have the world's telecom companies trying to convince large users to outsource management of their voice, data, and image-network services.

Even the promise of that market's 15% annual growth wasn't enough to unite a would-be consortium of telecom giants. Nippon Telegraph and Telephone and Deutsche Bundespost Telekom failed to join British Telecommunications at the launch of a new managed-network company. Instead, Telekom, France Telecom, and MCI Communications began separate talks on an alternate outsourcing consortia.

It's still unclear how successful the new arrangement will be. Originally, the three were to provide multinational users customized, high-speed, non-switched services. Instead, BT alone launched Atlanta-based Syncordia, which offers those same users network management services, customized billing, and multi-lingual customer service.

It won't be easy. "Outsourcing as a concept in telecom is still at a relatively early stage," says Laurence Heyworth, an analyst with Robert Fleming Securities Ltd. in London. That explains one thing: Syncordia had no customers at the time of its September launch. Amadeus, the airline reservations system, chose Syncordia to manage its trans-Atlantic service one week later. BT's Tymnet sales force will peddle Syncordia's services in the U.S.

—Barbara N. Berkman in London

STRATEGIES

IBM readies to sell OS/2 2.0 to other vendors

IBM's SEEMINGLY endless and some say fruitless battle to make OS/2 an industry standard is taking a new twist. Big Blue may start licensing OS/2 to rival PC vendors in a last-ditch effort to stem the rise of Microsoft's Windows 3.0.

IBM will begin shipping OS/2 Release 2.0 before the end of this year. Observers speculate that IBM, fearful that Microsoft may not aggressively market OS/2 2.0, will go one step further and license the PC operating system to competitors.

Such a move indicates "a profound attitude change at IBM—a recognition that cooperation with competitors can further a strategic objective," UBS Securities Inc. analyst Marc Schulman says in a report.

IBM and Microsoft, once united in their support of OS/2, have been moving apart in recent years with Microsoft increasingly emphasizing its successful Windows 3.0 system software. Although it's Microsoft's responsibility to license OS/2 2.0 to other vendors, IBM is worried that Microsoft may try to "sabotage" OS/2 by not actively marketing it, Schulman says. In order for OS/2 to succeed as an industry standard, other PC vendors must adopt it.

IBM is reportedly ready to step in and begin licensing OS/2 2.0 to other vendors within 45 to 60 days if it believes Microsoft is stalling. Schulman says IBM has already held discussions with other PC makers, including arch rival Compaq Computer.

—By Rick Whiting

DATA COMMUNICATIONS

Will Synernetics/3Com deal ripple the LAN hub market?

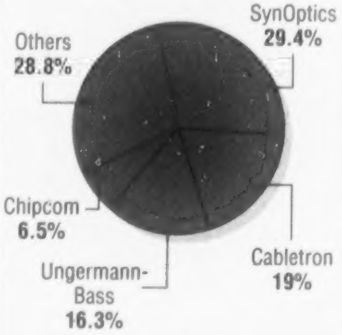
A TECHNOLOGY and development agreement between Synernetics and 3Com attempts to make a big splash in the business of intelligent networking hubs. Nevertheless, it's not expected to significantly challenge established vendors such as SynOptics and Cabletron.

Intelligent hubs have become a popular solution for achieving computer networking, racking up 1990 U.S. sales of $381 million, says Dataquest. A single hub typically supports several types of LANs and allows stations on attached networks to communicate with one another.

The five-year contract could bring start-up Synernetics up to $18 million in revenue and may help 3Com jump-start its hub operation. 3Com customers also can gain assurance that 3Com is laying the foundation for future development on their current generation of technology.

Intelligent hub market leaders

(% share, U.S. market)



1990 U.S. market = $381 million

Source: Dataquest Inc.

Synernetics introduced its LANplex 5000 intelligent hub in the fall of 1990. 3Com lagged in the development of its own hub and has been sourcing hubs from market-leader SynOptics. Now, for its next-generation product, 3Com will go with Synernetics.

3Com initially will resell the LANplex 5000 hub but has the right to manufacture its own hubs based on the architecture in the future. 3Com will also buy several Synernetics modules for the hubs, including an FDDI concentrator and a high-performance Ethernet module.

—By Dwight Davis in Seattle

SOFTWARE

Software pirates' booty costs industry big bucks

THE NEXT TIME YOU download that new software program for a co-worker consider this: In the eyes of the software industry, that's piracy, and you may be taking a bigger chance than you realize.

The software industry is getting more aggressive in prosecuting pirates because it's losing big bucks in potential revenue—an estimated $2.2 billion in the United States alone, according to a study by the Software Publishers Association (SPA).

Executive director Ken Wasch admits the SPA's bark has been worse than its bite, but its aggression is now fueled by added resources, by a piracy hotline, and by educating the user base. The last two work hand-in-hand: More than 95% of reported piracies come from employees blowing the whistle on their own companies. "It's a messy business," Wasch concedes. "We're filing suits at a rate of two per week." The SPA expects to file 100 suits on behalf of the industry in 1991—twice the number filed in either '89 or '90.

The recovered money from the suits goes into the SPA copyright protection fund. The group is also backing a proposal in the Senate that could give electronics software the same kind of protection granted to audio-visual software, making it a felony to copy and distribute it.

The SPA hotline is (800) 388-7478.

—By Barbara Jorgensen

MULTIPROCESSING SYSTEMS

Super servers attack enterprise-wide networking

SUN MICROSYSTEMS and Control Data this fall introduced multiprocessing systems aimed at capturing more of the high-performance network server market. In addition to opening a new market for box makers such as Sun, these systems offer Sparc and Mips chip makers the opportunity to sell not just one, but perhaps four or more chips into a single box.

Systems such as Sun's and CDC's target applications traditionally handled by superminis or mainframes. Such servers handle a large number of users and even other servers as well as complex data bases and applications.

The Sun servers are powered by multichip processor modules from Cypress. Cypress also adds value in the design of the modules, which reduces the OEM's design effort.

Sun unveiled the SparcServer 600MP Series with modular dual-processor designs that allow the Cypress modules to be easily replaced with new ones containing Sun's Viking processor produced by Texas Instruments.

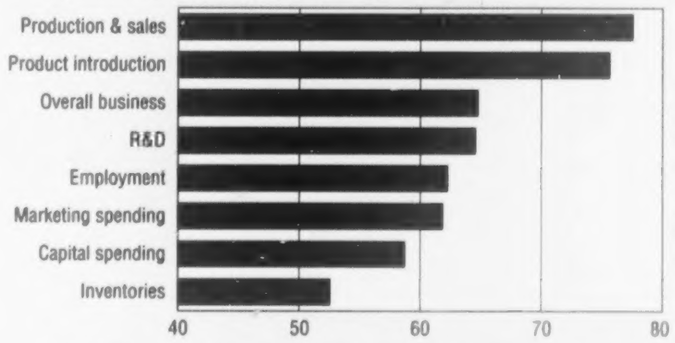
The CDC servers, with processors based on Mips' RISC architecture, are referred to as "Infoservers." Customers are looking to the new CDC 4680 systems to offer an upgrade path as processing needs increase.

Multichip processor modules are difficult to design because of timing problems between the different processors. Designing the cache controller and processor interface into an easily plugged-in module allows OEMs to get their systems and future upgrades to market faster, without the engineering expensive of designing their own processor interface.

—By Hugh G. Willett in San Jose

Capital spending expectations hang low...

Business confidence indicators for 1991 QIV*

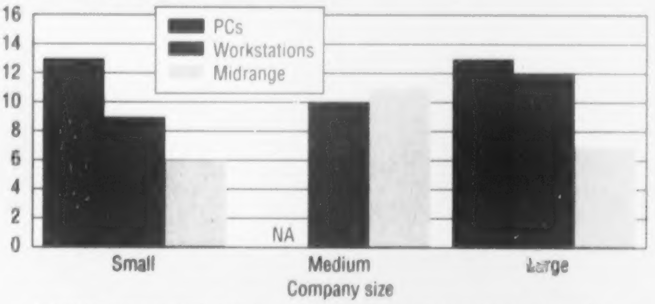


* Indicators are percentage of respondents who expect increases plus half of respondents who expect no change

Source: Cahners Economics survey, Sept. 1991

...but anticipated computer buys for '92 look better..

Indicators of computer buyers' plans*

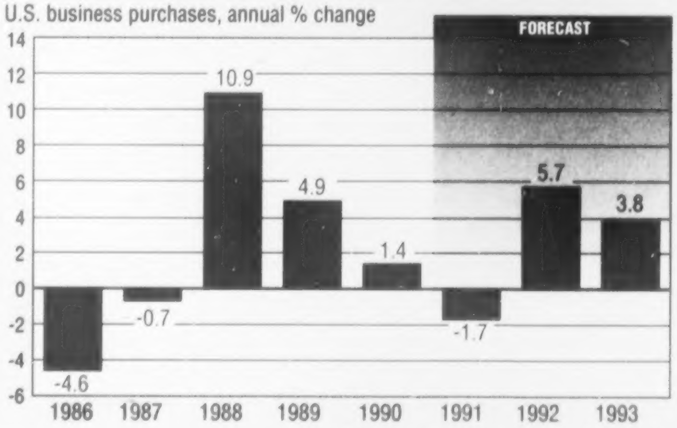


* Indicators are percentage of sites that expect to spend more minus sites that expect to spend less over the next 12 months
NA = not available

Source: Datamation/Cowen & Company survey, Sept. 1991

...which will help boost spending on computers

U.S. business purchases, annual % change



Source: Commerce Dept.; forecast: Cahners Economics

How investment drives computers

WHILE BUSINESS confidence slowly rekindles the economy, expectations for any immediate buying binge remain lukewarm, but spending will heat up once more in 1992 and 1993.

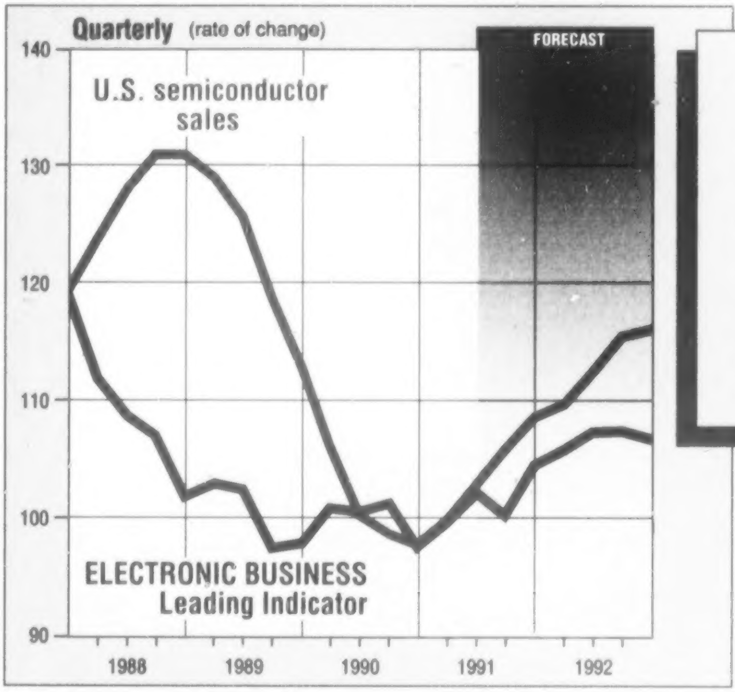
U.S. businesses purchased $40.7 billion worth of computers and office equipment last year, only a 1.4% increase. As the economy slid further into recession through the first half of this year, business spending for such equipment dropped 4.7% from fourth quarter 1990 to first quarter 1991 and dipped another tenth of a percent from the first quarter to the second. Cahners Economics predicts investment will be down 1.7% this year, the worst since a 4.6% loss in 1986. Cahners's new business confidence indexes confirms the forecast. Of all the barometers of business activity surveyed by Cahners, managers are most pessimistic about capital spending and inventory plans.

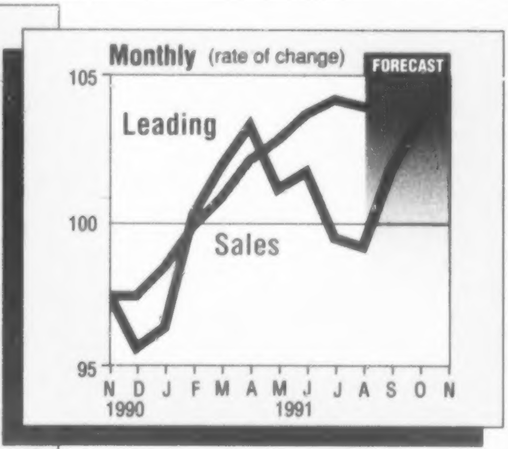
As usual, business managers want to see sustained growth in production and sales for several months before committing to new capital equipment purchases. Once companies overcome their spending shyness, computer and office equipment makers should benefit. A recent *Datamation*/Cowen & Company study on computer buying patterns revealed companies that anticipate increasing spending in the next 12 months for PCs, workstations, and midrange systems outnumber those that expect to cut spending.

With the economy recovering and businesses, in general, spending about 11% of their total equipment budget just on computers and office equipment alone, Cahners Economics maintains a bullish outlook for capital spending. The forecast calls for a 6% rise in U.S. business purchases of computers and office equipment in 1992 and a 4% gain in 1993.

—Madeline Franchi

ELECTRONIC BUSINESS Leading Indicator



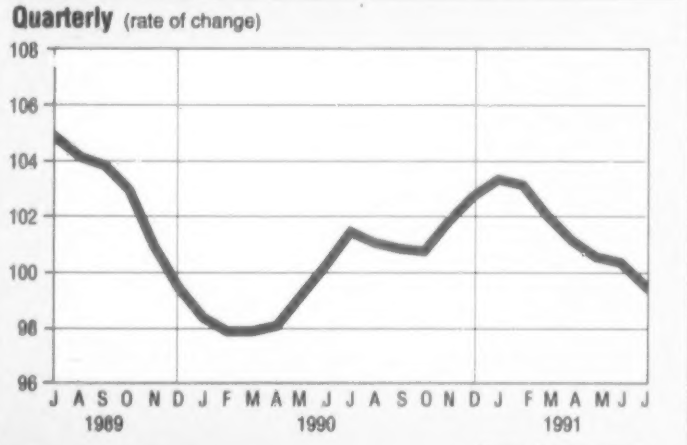


Summertime blues hit Leading Indicator

THE ELECTRONIC BUSINESS Leading Indicator (EBLI) fell again in August to 99.1, the second month below the break-even 100 mark. It is unclear if that is warning of a double-dip recession, but expect a period of anemic growth in the near-term before healthier gains in 1992. Inventory growth usually picks up before a recovery but has fallen for the past six months.

EBLI is a weighted composite of six statistics which lead activity in the electronics industry. To obtain a complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; or fax (617) 630-2100.

Cautious managers keep inventory lean



Source: Commerce Dept.

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, August)	99.1	99.4	100.8	99.9
U.S. semiconductor bookings ($ millions, 3-month average, August)	$1,206	$1,237	$1,220	$1,254
Weekly hours of semiconductor production workers (monthly average, July)	40.7	40.8	39.4	40.4
Electronic components lead time index (1977 = 100, September)	81.4	75.3	80.6	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, August)	72.3	68.3	64.1	64.6
Change in electronic components inventories ($ millions, SA, July)	$60	-$30	$208	$33
Contracts and orders for plant and equipment ($ billions, SA, July)	$39.1	$32.0	$39.9	$38.3

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing*, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis

INTERNATIONAL REPORT

Where's the RECESSION heading next?

As downturns go, this one has been the most confusing in memory. The recession seems to have taken on a life of its own as it hopscotches the globe and raises general mayhem before moving on.

In the following pages, we assess the damage wreaked by the economy during the past year and predict the fallout. Some highlights:

- The U.S. may be out of the woods, but keep the champagne on ice for a while. The expected improvement in gross national product during the second half of the year is unlikely to compensate for limping production rates and tight credit policies attributable to the S&L scandal;
- Officially, Western Europe is out of the recession. Unofficially, most of its economies are in limbo because of the collapse of the former Soviet bloc and a slowdown by the German juggernaut as it integrates its eastern regions. Don't expect much real growth before 1993;
- Even Japan is looking a bit wan. Growth, both this year and next, is pegged at 3.5%, compared with last year's 5.6%. Also, look for a rising yen to put a crimp in Japanese exports and a possible domestic labor shortage that will drive up production costs;
- If you're looking for solid growth prospects, try the Pacific Rim nations. Sources predict major high-tech expansion in the area, particularly in Taiwan. Projected growth rates for next year range as high as 8% for South Korea, and 7.5% for Singapore.

UNITED STATES

The recession is over. Now for the doldrums

Although the GNP fell 0.5% in the second quarter, the recession is probably already over. Economists point to increased industrial production for the five consecutive months beginning in March. However, the electronics industry should expect little in the way of a post-recession boom.

"Despite signs of improvement, the numbers aren't anything to get excited about," says Richard O'Brien, chief economist of Hewlett-Packard Co. in Palo Alto, Calif.

This uninspiring recovery has been with us since the beginning of the year. The ELECTRONIC BUSINESS Leading Indicator turned the corner in January, but Cahners economist Madeline Franchi expects the index to rise only 14 points between January and June of 1992—a far cry from the 30-point increase in the 10 months following the 1985 recession.

Chip markets should show the most growth. The Semiconductor Industries Association says North American chip sales will rise 8.5% this year and 16% in 1992. Sales of capital equipment, computers, and telecommunications will remain sluggish—well under 10%.

A host of factors dampen the U.S. recovery. Defense cutbacks hurt OEM sales. The rise of the U.S. dollar overseas in response to political turmoil and weak economies abroad shackles exports. Improved inventory control by U.S. companies will temper the recovery as it tempered the recession. Fiscal conservation by the Federal Reserve Bank, along with the savings and loan crisis and the shaken confidence of the nation's banks, should keep credit tight.

—By Peter Burrows

North America at a glance in 1990

Population = 276.2 million
Size of economy = $5.4 trillion (U.S. $)
Size of electronics market = $232 billion (U.S. $)
Gross domestic product per capita = $19,551 (U.S. $)
Education indicator* = 60% to 62%

North America includes United States and Canada
*Percentage of 20- to 24-year-olds getting a post-secondary education in 1988

The outlook

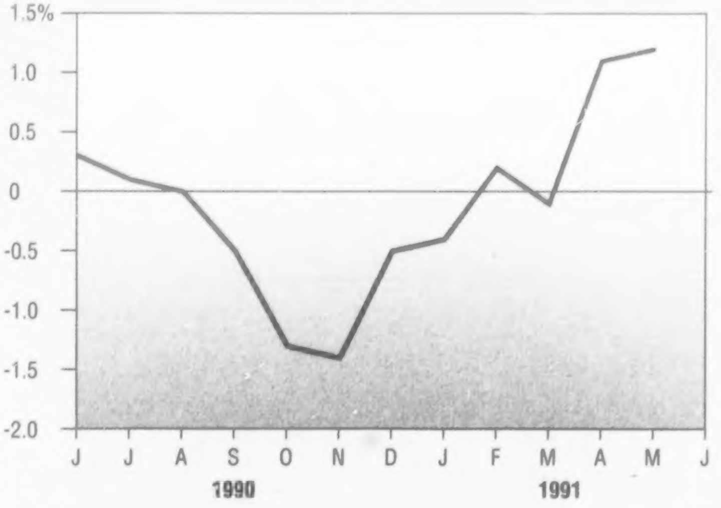
(annual % change**)

	1990	1991	1992
GNP	0.9%	-0.3%	3.1%
Electronics market	0.7	-0.1	2.9
Best growth prospects:			
Automotive electronics	-1.7	0.6	24.2
Semiconductors	-2.6	8.5	16.0
Worst growth prospects:			
Government and military	0.41	-0.2	-2.9
Consumer electronics	-0.3	-2.0	7.4

**GNP adjusted for inflation; all data assumes constant exchange rates

North America's economic leading indicator

(monthly % change)



Source: Cahners Economics, Columbia University's Center for International Business Cycle Research, Elsevier Advanced Technology, The World Bank, Organization for Economic Cooperation and Development, International Monetary Fund, Electronic Outlook Corp.

WESTERN EUROPE

Western Europe limps along

Buffeted by a global recession, the opening of the Eastern bloc, and various country-specific problems, Western Europe will escape 1991 with a collective GNP growth of just over 2%. While the region is no longer in recession, whatever it is in isn't much better.

The region's growth should improve slightly to 2.4% in 1992, according to Elsevier Advanced Technologies in London, but don't expect any hot spots to emerge. Germany, the locomotive of the European economy, will grow only 2% as it struggles to integrate the economy of the former East Germany. German trading partners such as Austria, Denmark, and the Netherlands will fare just a few tenths of a percentage point better. Scandinavia will suffer from a dearth of activity with a tumultuous U.S.S.R. and an impoverished former Eastern bloc. France grapples with losses at state-supported companies, and Spain and Italy struggle with labor shortages and inflation set off by manufacturing investments in the 1980s. The U.K., meanwhile, wonders why it is still in the throes of the recession.

Simply stated, the political turmoil in Europe and the Middle East will prevent a meaningful economic upturn. Western European companies anticipate the integration of the European Community and the creation of an economic infrastructure for Eastern Europe. Even erstwhile trading partners in the Middle East are uncertain, as Iraq remains in economic quarantine and Saudi Arabia and Kuwait favor U.S. companies in return for America's leadership role in the Gulf war.

—By Peter Burrows

Western Europe at a glance in 1990

Population = 233.4 million
Size of economy = $4.2 trillion (U.S. $)
Size of electronics market = $131 billion (U.S. $)
Gross domestic product per capita = $17,995 (U.S. $)
Education indicator* = 23% to 32%

Western Europe includes Germany, United Kingdom, Italy, and France
*Percentage of 20- to 24-year-olds getting a post-secondary education in 1988

The outlook

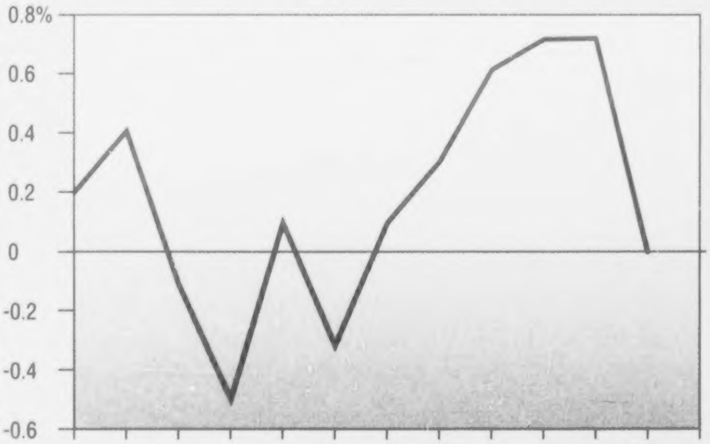
(annual % change**)

	1990	1991	1992
GDP	2.9%	1.2%	2.2%
Electronics market	2.5	2.6	3.0
Best growth prospects:			
Automotive electronics	11.1	15.9	13.2
Communications	7.2	5.0	8.5
Worst growth prospects:			
Government and military	5.1	5.4	5.3
Instruments	7.0	1.2	5.4

**GDP adjusted for inflation; all data assumes constant exchange rates

Western Europe's economic leading indicator

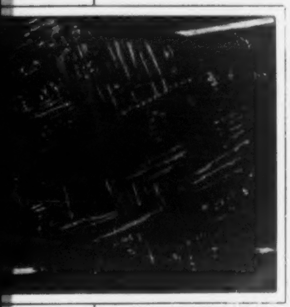
(monthly % change)



Source: Columbia University's Center for International Business Cycle Research, Elsevier Advanced Technology, The World Bank, Organization for Economic Cooperation and Development, International Monetary Fund, Electronic Outlook Corp.

JAPAN

Is Japan next in line for the recession?



The Japanese juggernaut may be running out of steam.

Not that Japan's economy is on the verge of a major contraction or that its influence in world electronics markets is on the wane. Japan "is certainly up there at the top of the list of countries in good economic health," says Paul Nesdore, manager of international planning services at IDC.

Observers, however, are sounding warning bells about Japan's economy, the world's second-largest. Citing a sharp decrease in its leading index for the last year, The Conference Board Inc., a New York-based economic research firm, concludes that the Japanese economy is "headed for a slowdown or recession."

The U.S. Department of Commerce predicts that Japan's GNP will grow by around 3.5% both this year and in 1992, down from last year's 5.6%. The Singapore-based Pacific Economic Cooperation Conference expects GNP to reach only 3% this year and 4.3% in 1992. The Conference Board also expects the Japanese yen to strengthen over the next few years, making Japanese goods more expensive in foreign markets.

Nesdore says there are opportunities for U.S. companies in Japan "if you're in the right sector and if you know what you're doing." Demand for computer software and services in Japan is expected to grow 17% a year through 1995, for example. The IDC analyst speculates that a projected labor shortage could force Japan to import more electronics products such as components rather than manufacture everything itself.

—By Rick Whiting

Japan at a glance in 1990

Population = 123.5 million
Size of economy = $2.8 trillion (U.S. $)
Size of electronics market = $131 billion (U.S. $)
Gross domestic product per capita = $22,672 (U.S. $)
Education indicator* = 30%

*Percentage of 20- to 24-year-olds getting a post-secondary education in 1988

The outlook

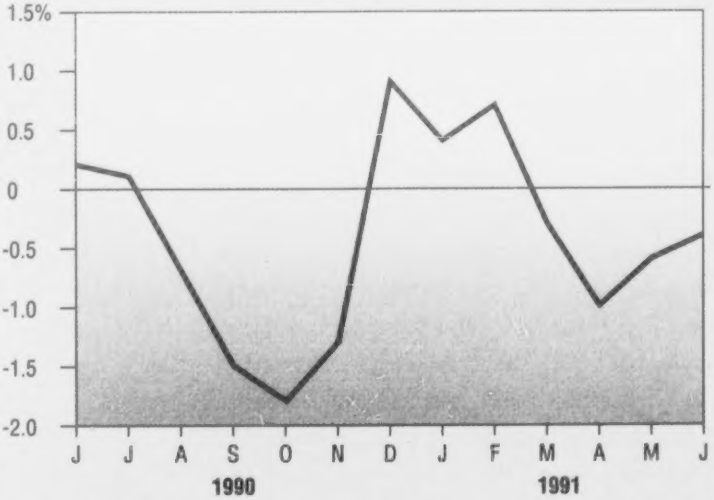
(annual % change**)

	1990	1991	1992
GDP	5.6%	3.5%	3.5%
Electronics market	4.5	3.6	5.0
Best growth prospects:			
Automotive electronics	6.4	7.0	14.9
Computers	4.2	6.0	13.1
Worst growth prospects:			
Consumer electronics	3.8	3.1	7.2
Government and military	5.0	4.6	6.2

**GDP adjusted for inflation; all data assumes constant exchange rates

Japan's economic leading indicator

(monthly % change)

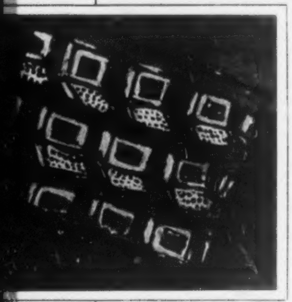


Source: Columbia University's Center for International Business Cycle Research, Elsevier Advanced Technology, The World Bank, Organization for Economic Cooperation and Development, International Monetary Fund, Electronic Outlook Corp.

INTERNATIONAL REPORT

PACIFIC RIM

Pacific Rim beckons U.S. companies on the move



The Asia/Pacific Rim area presents a paradox for growth-minded U.S. electronics companies. On one hand, Taiwan and Korea face rising labor costs, Thailand often appears politically unsettled, and Hong Kong is beset by uncertainty about China's scheduled 1997 takeover. On the other hand, the region is a hotbed of growth and opportunity.

"The economies of the Asia/Pacific countries are stronger than those of the United States and Europe," says Thomas Hillman, managing director of international operations for Star Technologies Inc., a Sterling, Va., vendor of network computer servers.

Taiwan is rebounding from a mild recession, and South Korea's economy is expanding at a steady clip. A report from the Pacific Economic Cooperation Conference (PECC) predicts that South Korea's gross domestic product (GDP) will increase by 8.5% this year and 8% in 1992. The U.S. Department of Commerce estimates that Taiwan's economy will expand 8% this year and 5% in 1992. International Data Corp. (IDC) predicts economic growth of about 7% this year in Singapore and 3% in Hong Kong.

Other fundamental changes are underway in the Pacific Rim. Increasing labor costs are pushing volume manufacturing operations from Taiwan and Korea to Thailand, Malaysia, and the Philippines. The PECC report forecasts that Thailand's GDP will grow 9% this year and 6.8% in 1992. Malaysia's GDP growth will be 8.3% in 1991 and 8% in 1992, while Singapore will see 7.5% growth next year.

—By Rick Whiting

Pacific Rim at a glance in 1990

Population = 71.4 million
Size of economy = $435 billion (U.S. $)
Size of electronics market = $35 billion (U.S. $)
Gross domestic product per capita = $6,092 (U.S. $)
Education indicator* = 37% to 44%

Pacific Rim includes Singapore, South Korea, Hong Kong, and Taiwan
*Percentage of 20- to 24-year-olds getting a post-secondary education in 1988

The outlook

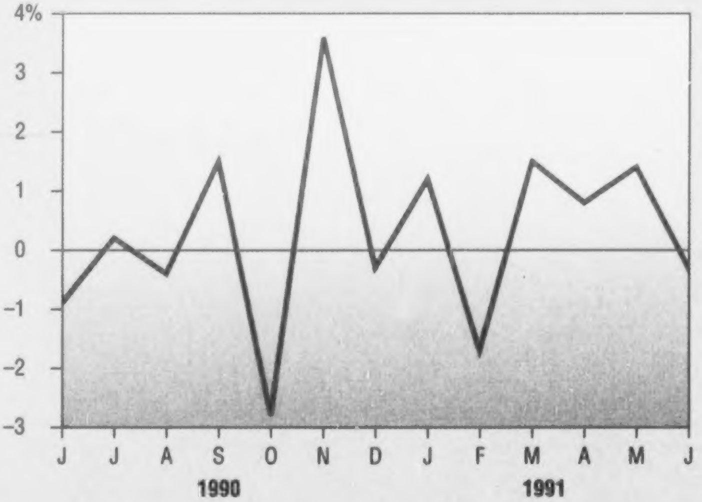
(annual % change**)

	1990	1991	1992
GDP	5.9%	5.6%	6.5%
Electronics market	5.2	5.0	6.0
Best growth prospects:			
Semiconductors	18.2	19.7	19.7
Computers	8.0	10.7	18.7
Worst growth prospects:			
Government and military	8.8	8.8	11.1
Industrial electronics	10.6	7.0	12.4

**GDP adjusted for inflation; all data assumes constant exchange rates

Pacific Rim's economic leading indicator

(monthly % change, Taiwan and S. Korea only)



Source: Cahners Econmomics, Columbia University's Center for International Business Cycle Research, Elsevier Advanced Technology, The World Bank, Organization for Economic Cooperation and Development, International Monetary Fund, Electronic Outlook Corp.

The Electronic Business International 100

To no one's surprise, Japan takes 6 of the top 10 spots in this year's ranking of the world's largest electronics companies

By Linda Stallmann

The world's top 100 electronics companies generated $715 billion in electronics sales in 1990, up 11% from 1989. Not surprisingly, the biggest gains came in Japan, where electronics sales jumped almost 21% to $272 billion.

North American companies still dominate the list with 43 entries (42 U.S. and 1 Canadian), down from 47 last year. Asian companies took up the slack, bringing their number to 34. European entries remains at 23.

The five top companies profiled below accounted for $179 billion worth of electronics goods and services—a whopping 25% of the total. Of the five, three are based in Japan, one in the U.S., and one in Germany.

1. IBM

FINANCIAL RESULTS for the world's largest electronics company improved substantially over 1989. IBM's worldwide sales rose 10%, to $69 billion in 1990, and net earnings climbed from $3.8 billion to $6 billion. Earnings in 1989, however, had been hit by a $2.4 billion pre-tax restructuring charge.

Non-U.S. operations came in at $41.9 billion (up 13.3%), due mostly to a 17.5% increase in European revenue. Domestic operations rose 5.4% to $27.1 billion last year and posted the best annual growth rate since 1984.

IBM's revenue from hardware sales was $44 billion, an increase of 5.7%. While hardware

Vital signs: How the U.S., Europe, and Japan compare

	Electronics sales ($ billions)	% change from prior year	Total sales ($ billions)	% change from prior year	5-year sales growth (CAAGR)*	Net income ($ billions)
Asia	$271.5	20.7%	$498.5	11.2%	10.2%	$15.8
Europe	156.4	5.5	400.7	5.9	8.3	8.1
North America	287.5	7.7	639.4	11.9	8.6	31.7
International 100	715.4	11.4	1,538.6	9.0	9.0	55.6

All data is weighted averages except for net income, electronics, and total sales

* compounded average annual growth rate (% per year)

remained the largest single revenue generator at 63.7% of total sales, the growth rate in software and services continued to outpace it. Revenue from support services increased 15%, to $11.3 billion; software rose 18.1%, to $10 billion; and rentals and financing grew 30%.

During the first half of 1991, IBM has been affected by "continued weakness in global economies, competitive pressures, and product line transitions," says chairman John F. Akers. Worldwide sales during the period fell 7.8% to $28.3 billion. Profits tumbled 74% to just $646 million. Hardware sales dropped 19.7% while all other areas increased—support services by 17.1%, software by 6.6%, and rentals and financing by 14.4%. □

Matsushita Electric

2.

THE SECOND-LARGEST electronics company weighed in at $33.3 billion in electronics sales last year. For Matsushita—which markets under the brand names of Panasonic, National, Technics, and Quasar—fiscal 1991 was a year of solid growth. Total sales increased 10% to $46.7 billion. Net income grew 10% to $1.8 billion. Consolidated overseas sales (mostly in Asia and Europe) advanced 13% to $21 billion. Domestic sales rose just 7% to $25.8 billion. In December 1990, Matsushita acquired MCA Inc., the U.S. entertainment company, for approximately $6.1 billion. (MCA's financial results are not included in Matsushita's consolidated fiscal year results.)

Sales growth was posted in all major product groups. Revenue from video equipment—Matsushita's largest segment, with 26% of total sales—grew 7% to $12 billion. Communications and industrial equipment, with 24% of sales, rose 13% to $11 billion. Home appliances, batteries, and kitchen-related products all grew 12%, while electronic components sales rose 8% and audio equipment sales, 7%.

In the first fiscal quarter of 1991, ended in June, Matsushita's profits dropped 34% to $271 million. Sales climbed 12% to $12.6 billion. The earnings decline was due largely to the costs associated with the MCA purchase, to a slowdown in Japan's economic growth, and to a downturn in the U.S. economy. □

3. NEC

NEC'S $26 BILLION in sales came primarily from communications systems and equipment, computers and industrial electronics systems, and electronic devices. In fiscal 1991, ended Mar. 31, the company faced continued, but slowing, growth in demand. In this environment, sales were up 7% from the previous year to $26 billion. Net income, however, fell 36% to $385 million.

Classified by products, sales of communications systems and equipment came in at $7.4 billion, a rise of 12% over the previous year, reflecting robust sales of cellular mobile communications equipment. Sales of computers and industrial electronics systems, boosted by domestic demand for PCs, reached $12.5 billion, a 10% increase. Sales of electronic devices, which were adversely affected by the decline in memory prices, fell 2% to $4.6 billion.

NEC's domestic sales depended upon computers and communications equipment and

% change from prior year	**Net income** (% of sales)	**Return on equity**	**Return on investment**	**Debt to capital**	**Sales per employee**	**R&D** (% of sales)	**Capital expenditures** (% of sales)
2.8%	3.2%	10.3%	5.6%	45.4%	$228,191	3.3%	7.4%
-40.8	2.0	7.7	4.3	44.5	126,107	5.4	6.0
0.8	5.0	12.8	5.9	53.7	156,836	5.5	7.7
-6.6	3.6	11.0	5.5	49.6	163,003	4.8	7.1

Some companies do not have completed data

Source: ELECTRONIC BUSINESS

were supported by active private capital investment and strong consumer spending. Domestic sales rose 11% to $20.1 billion. Overseas sales fell 3% to $6.1 billion, largely because of falling memory prices and NEC's withdrawal from the audio-visual business in the U.S. □

4. TOSHIBA

WITH ELECTRONICS SALES climbing 17% to $25 billion, Toshiba moved from the number-six spot in the 1990 ranking to this year's number-four position. Total consolidated sales (20% of which are heavy electrical apparatus sales) rose 10% to $33 billion during the year ended Mar. 31 1991. Competition in the key electronics markets hurt Toshiba's margins, however, leading to an 8% decrease in profits, to $855 million. Overseas sales rose 8%, to $10 billion and accounted for 31% of total revenue. An active investment and acquisition program is expected to raise overseas sales to 39% of total sales by 1993.

By segment, information and communications systems sales rose 9%, to $18 billion. Sales of notebook and laptop computers jumped 40%, to $1.4 billion. Memory sales were flat, but sales of application-specific ICs powered total semiconductor growth to 6%. Consumer products rose 9% to $10.7 billion. □

5. SIEMENS

SIEMENS RACKED up $25 billion in electronics sales last year as well, $4 million short of fourth-ranked Toshiba. In its fiscal year ended Sept. 1990, the diversified German company's total sales rose 3% to top $37 billion; profits climbed 6% to nearly $985 million. The 1990 acquisition of Nixdorf Computer, the integration of the Data and Information Systems Group, and the consolidation of the two units into Siemens-Nixdorf Informationssysteme was completed by year-end.

Sales increases came in all the electronics groups except for semiconductors, where revenue fell 12.2% to $1.2 billion, and audio and video systems sales, which slid 14.7% to $72 million. Data and information systems sales jumped nearly 30% to $4.5 billion. Double-digit growth also was reported by defense electronics, automation, public communication networks, and industrial and building systems.

In the nine months ended June 30, 1991, total sales rose 12% over the year-ago period to reach $30 billion. Profits rose 7% to $710 million. Growth wasn't entirely due to extraordinary factors; Siemens cites orders up 20%. □

Editorial assistant Quang Bao contributed to this report

Notes to the ELECTRONIC BUSINESS International 100

Electronics sales: Either a published figure or an ELECTRONIC BUSINESS estimate of revenue earned by each company from sales of electronics products and services

Net income: Income from continuing operations after taxes and before extraordinary items or charges. Includes minority interest

Return on equity: Net income after taxes as a percentage of shareholder's equity (preferred stock, capital stock, surpluses, and retained earnings at the company's year end)

Return on investment: Net income as a percentage of shareholder's equity, short-term and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable, and other borrowings

Debt to capital: Includes long-term and short-term debt as a percentage of shareholders' equity plus debt

Employees: In most cases, the average for the year

R&D: Company-sponsored research and development expenses as a percentage of total sales

Capital expenditures: Investment in property, plant, and equipment as a percentage of total sales

Foreign sales: Includes the country of origin's sales to other regions as a percentage of total sales

All figures shown are based on the latest available completed fiscal year, so various accounting periods are represented. Similarly, electronics sales and other financial information have been converted to dollars using an exchange rate for the average rate during each company's fiscal year. □

Top 100 International electronics companies

	Company Location	Electronics sales ($ millions)	% change from prior year	Total sales ($ millions)	% change from prior year	5-year sales growth (CAAGR)*	Net income ($ millions)
1	**IBM** United States	$69,018	10.1%	$69,018	10.1%	6.4%	$6,020
2	**Matsushita** Japan	33,320	9.1	46,708	9.9	6.5	1,833
3	**NEC** Japan	26,179	7.4	26,179	7.4	9.6	385
4	**Toshiba** Japan	25,048	17.2	33,232	10.4	6.8	855
5	**Siemens** Germany	25,044	11.6	37,321	3.4	3.0	985
6	**Philips** Netherlands	23,846	-2.9	30,640	-2.6	-1.5	-2,487
7	**Hitachi** Japan	22,853	14.2	54,759	9.3	9.1	1,629
8	**Fujitsu** Japan	21,031	16.5	21,031	16.5	11.9	585
9	**Sony** Japan	20,419	23.7	25,596	25.6	20.0	828
10	**AT&T** United States	16,832	1.5	37,285	3.2	1.6	2,735
11	**NTT** Japan	14,969	NA	44,246	3.8	NA	1,848
12	**Alcatel Alsthom** France	14,233	-8.2	26,456	0.1	13.0	943
13	**Xerox**[1] United States	13,583	9.3	13,583	9.3	8.4	599
14	**Thomson** France	13,482	3.0	13,816	-1.9	4.7	-454
15	**Hewlett-Packard** United States	13,233	11.2	13,233	11.2	15.3	739
16	**Digital Equipment** United States	12,943	1.6	12,943	1.6	14.1	74
17	**Mitsubishi** Japan	11,776	12.0	23,471	11.4	-28.0	565
18	**GM Hughes Electronics** United States	11,723	3.2	11,723	3.2	4.3	577
19	**Canon** Japan	11,683	27.5	11,932	27.9	12.6	424
20	**Motorola** United States	10,885	13.1	10,885	13.1	14.8	499
21	**GEC** Britain	10,406	23.7	17,430	7.9	11.3	923
22	**Unisys** United States	10,111	0.1	10,111	0.1	15.0	-437
23	**General Electric** United States	9,430	5.7	58,414	7.0	12.4	4,303
24	**Sharp** Japan	9,000	13.4	10,847	12.0	4.7	332
25	**Robert Bosch** Germany	7,983	3.8	19,693	4.0	8.4	346
26	**Olivetti** Italy	7,392	-1.9	7,543	0.1	8.0	50
27	**Ericsson** Sweden	7,118	18.0	7,720	15.6	7.1	583
28	**Northern Telecom** Canada	6,769	10.9	6,769	10.9	9.5	460
29	**Texas Instruments** United States	6,567	0.7	6,567	0.7	5.9	-39
30	**Samsung** South Korea	6,371	12.6	6,371	12.6	21.6	103
31	**Groupe Bull** France	6,351	5.7	6,351	5.7	16.5	-1,247
32	**Honeywell** United States	6,309	4.1	6,309	4.1	8.4	372
33	**NCR** United States	6,285	5.5	6,285	5.5	7.8	369
34	**Ricoh** Japan	6,187	25.7	7,101	20.1	11.1	96
35	**Apple Computer** United States	5,558	5.2	5,558	5.2	23.7	475
36	**Raytheon** United States	5,517	3.4	9,268	5.4	7.7	557
37	**Sanyo** Japan	5,161	7.4	10,106	7.8	-0.4	120
38	**Rockwell International** United States	5,001	-0.6	12,379	-3.3	1.8	624
39	**Oki** Japan	4,678	4.9	4,678	4.9	11.0	70
40	**Tandy** United States	4,500	7.6	4,500	7.6	11.6	290
41	**Nokia** Finland	4,396	15.8	5,780	-2.9	15.0	90
42	**Pioneer** Japan	4,244	17.2	4,244	17.2	11.6	243
43	**Eastman Kodak** United States	4,140	-1.4	18,908	2.8	12.2	703
44	**STC** Britain	4,078	-11.9	4,078	-11.9	2.8	96
45	**Intel** United States	3,921	25.4	3,921	25.4	23.5	650
46	**Lockheed** United States	3,880	1.3	9,958	0.7	1.5	335
47	**IRI** Italy	3,834	10.2	61,391	10.2	7.8	925
48	**TDK** Japan	3,822	13.0	3,822	13.0	7.0	201
49	**British Telecom** Britain	3,618	14.2	24,180	6.8	9.6	3,824
50	**Compaq Computer** United States	3,599	25.1	3,599	25.1	48.2	455

NA = not available
NM = not meaningful

[1] Data for Xerox's document-processing business only (omits insurance and financial services business)

*compounded average annual growth rate (percent per year)

% change from prior year	Net income (% of sales)	Return on equity	Return on investment	Debt to capital	Sales per employee	R&D (% of sales)	Capital expenditures (% of sales)	Foreign sales ** (% of sales)	Rank
60.2%	8.7%	14.1%	9.7%	31.3%	$184,631	9.5%	9.4%	60.7%	12/90
9.9	3.9	7.5	4.2	44.0	221,522	5.8	7.2	45.0	3/91
-36.2	1.5	6.2	2.4	61.6	221,865	7.6	9.9	23.4	3/91
-8.3	2.6	10.3	4.1	60.4	205,138	6.4	9.7	31.0	3/91
5.8	2.6	9.5	7.7	18.8	100,057	11.0	6.9	55.0	9/90
-671.5	-8.1	-34.2	-14.5	57.7	112,315	7.9	5.1	93.5	12/90
9.1	3.0	8.2	5.0	39.1	176,782	6.3	9.6	24.0	3/91
-4.7	2.8	7.1	3.4	52.6	144,203	11.1	10.6	24.8	3/91
13.7	3.2	7.9	3.9	50.2	226,718	5.7	11.4	73.7	3/91
1.4	7.3	19.4	13.4	30.9	136,226	6.5	9.7	NA	12/90
-14.0	4.2	6.1	3.0	49.9	167,025	4.4	25.9	NA	3/91
4.0	3.6	10.8	6.0	44.3	128,740	8.4	4.9	62.6	12/90
22.7	4.4	9.8	3.6	63.0	137,202	6.2	3.3	50.7	12/90
-597.8	-3.3	-12.2	-5.6	54.4	131,007	6.0	5.6	70.3	12/90
-10.9	5.6	11.6	8.8	24.2	143,837	10.3	7.2	54.4	10/90
-93.1	0.6	0.9	0.9	1.9	104,375	12.5	7.9	56.3	6/90
3.9	2.4	NA	NA	NA	242,002	NA	NA	19.0	3/91
-8.7	4.9	7.1	6.4	10.8	122,116	4.8	7.5	16.2	12/90
60.4	3.6	9.9	4.9	50.5	219,409	5.0	7.9	70.6	12/90
0.2	4.6	11.7	8.3	29.6	103,667	9.3	11.5	54.2	12/90
-7.6	5.3	18.4	15.6	15.3	147,054	4.6	2.7	58.7	3/91
NM	-4.3	-12.5	-6.1	51.7	134,280	7.4	4.6	51.8	12/90
9.2	7.4	19.8	5.0	74.7	196,020	2.5	7.7	25.9	12/90
12.6	3.1	NA	NA	NA	301,280	NA	NA	46.0	3/91
-10.6	1.8	8.5	6.7	21.0	109,628	6.4	8.8	51.0	12/90
-70.2	0.7	1.7	0.7	62.1	140,515	5.2	4.6	63.4	12/90
87.2	7.5	20.6	15.7	24.0	109,911	10.7	7.5	82.0	12/90
22.2	6.8	14.0	10.0	28.3	138,027	11.4	6.5	64.2	12/90
-113.4	-0.6	-1.7	-1.3	24.1	93,390	8.2	13.8	33.2	12/90
-54.0	1.6	NA	NA	NA	154,688	NA	NA	59.0	12/90
NM	-19.6	NM	NM	109.3	142,790	8.6	6.5	NA	12/90
-32.4	5.9	21.9	15.3	29.9	104,573	4.4	4.0	31.8	12/90
-10.4	5.9	20.6	16.0	22.6	114,273	8.0	6.4	61.9	12/90
-14.6	1.4	3.7	1.6	58.1	191,914	5.5	7.1	31.6	3/91
4.6	8.5	32.8	30.3	7.8	382,602	8.6	4.0	41.7	9/90
5.4	6.0	19.6	12.9	34.1	120,830	2.9	4.2	17.4	12/90
3.9	1.2	2.4	1.2	48.4	183,340	5.1	7.4	44.2	11/90
-15.0	5.0	14.9	11.3	24.5	121,451	13.7	4.3	26.2	9/90
-39.7	1.5	5.1	1.8	65.3	230,682	6.2	11.4	28.9	3/91
-10.2	6.5	16.8	10.9	35.5	115,374	0.0	2.5	6.7	6/90
25.5	1.6	4.3	2.1	51.5	154,799	5.3	4.8	55.3	12/90
16.5	5.7	11.1	9.2	16.5	277,286	3.8	8.1	58.5	3/91
32.9	3.7	10.4	5.0	52.5	140,632	7.0	1.1	46.5	12/90
-69.3	2.4	5.5	5.4	1.8	121,438	11.3	4.2	31.4	12/90
66.3	16.6	18.1	15.4	14.8	164,070	13.2	17.3	46.0	12/90
5483.3%	3.4%	14.5%	7.8%	46.3%	$136,411	4.5%	3.4%	7.1%	12/90
26.5	1.5	NA	NA	NA	146,170	NA	NA	NA	12/90
22.8	5.3	7.8	5.6	28.5	151,672	4.8	13.5	51.3	3/91
37.8	15.8	19.5	13.2	32.3	90,427	1.8	21.0	NA	3/91
36.5	12.6	24.5	23.5	3.8	315,681	5.2	9.0	53.9	12/90

** foreign sales are those outside country of origin

Top 100 international electronics companies

	Company Location	Electronics sales ($ millions)	% change from prior year	Total sales ($ millions)	% change from prior year	5-year sales growth (CAAGR)*	Net income ($ millions)
51	**3M** United States	$3,530	7.1%	$13,021	8.6%	9.9%	$1,308
52	**Asea Brown Boveri** Switzerland	3,500	30.6	26,688	29.8	NA	590
53	**Nintendo** Japan	3,337	14.4	3,337	14.4	30.8	488
54	**Alps** Japan	3,271	14.8	3,271	14.8	5.1	59
55	**AEG** Germany	3,257	1.2	8,137	7.4	3.9	-127
56	**Nippondenso** Japan	3,254	31.6	10,438	16.0	NA	435
57	**Omron** Japan	3,250	11.9	3,287	11.6	10.9	150
58	**Ford Motor** United States	3,250	7.7	97,650	17.8	13.1	860
59	**Westinghouse Electric** United States	3,196	14.8	12,915	0.6	2.8	268
60	**Litton Industries** United States	3,166	-3.0	5,156	2.7	2.4	179
61	**Goldstar** South Korea	3,110	14.7	4,200	14.6	NA	47
62	**Harris** United States	3,053	37.9	3,053	37.9	9.2	131
63	**Martin Marietta** United States	2,983	-6.4	6,126	5.7	6.7	328
64	**TRW** United States	2,980	3.8	8,169	11.3	6.7	208
65	**ITT** United States	2,925	1.3	20,604	2.7	0.6	1,056
66	**Toyota** Japan	2,900	5.2	62,443	14.6	NA	2,998
67	**Grundig** Germany	2,887	20.0	2,887	20.0	9.3	121
68	**Allied-Signal** United States	2,840	-2.0	12,343	3.4	8.6	462
69	**Kyocera** Japan	2,754	6.1	3,264	9.5	7.7	228
70	**Bayer** Germany	2,647	19.0	25,769	-3.8	-1.9	1,178
71	**Boeing** United States	2,600	7.4	27,595	36.1	15.0	1,385
72	**Citizen** Japan	2,600	26.4	2,896	22.3	NA	121
73	**AMP** United States	2,587	8.8	3,044	8.8	13.2	287
74	**Fiat** Italy	2,504	30.5	47,752	10.0	15.7	1,346
75	**GTE** United States	2,500	16.8	18,374	5.5	5.0	1,541
76	**Wang Laboratories** United States	2,497	-13.0	2,497	-13.0	1.4	-629
77	**DuPont** United States	2,480	7.8	40,047	12.7	6.3	2,310
78	**Sun Microsystems** United States	2,466	39.7	2,466	39.7	84.5	111
79	**Seagate Technology** United States	2,413	75.9	2,413	75.9	62.2	117
80	**Fuji Electric** Japan	2,400	12.3	5,933	8.9	NA	157
81	**Casio** Japan	2,378	10.2	2,373	10.0	5.2	65
82	**Emerson Electric** United States	2,348	6.1	7,573	7.1	9.0	613
83	**Seiko**[2] Japan	2,300	1.2	3,029	1.4	NA	5
84	**Minolta** Japan	2,300	20.4	2,622	6.6	3.7	-15
85	**Pitney Bowes** United States	2,283	7.7	3,196	11.1	12.3	207
86	**Amdahl** United States	2,159	2.7	2,159	2.7	20.2	184
87	**Ascom** Switzerland	2,128	11.6	2,128	11.6	NA	37
88	**Racal Electronics** Britain	2,022	-4.8	3,831	5.6	10.5	200
89	**Matsushita Electric Works** Japan	2,000	22.9	7,084	15.7	NA	228
90	**Matra** France	2,000	7.9	4,471	10.2	10.4	111
91	**Murata** Japan	1,967	12.2	1,963	11.9	6.2	178
92	**McDonnell Douglas** United States	1,915	16.0	16,255	11.4	7.4	275
93	**Memorex Telex** Netherlands	1,870	-5.7	1,870	-5.7	19.2	-274
94	**Tandem Computers** United States	1,866	14.3	1,866	14.3	24.0	122
95	**Daewoo** South Korea	1,852	9.2	1,852	9.2	NA	18
96	**Mannesmann** Germany	1,772	14.2	14,816	7.2	5.2	294
97	**Nissan** Japan	1,700	2.2	42,217	5.6	NA	345
98	**Nikon** Japan	1,700	6.0	2,161	7.3	NA	123
99	**Yokogawa** Japan	1,700	5.3	1,796	5.4	NA	70
100	**Control Data** United States	1,691	-42.4	1,691	-42.4	-14.4	3

[2] Sales of Seiko Corp. (formerly Hattori Seiko) only. Does not includes sales of Seiko Epson and Seiko Instruments

% change from prior year	Net income (% of sales)	Return on equity	Return on investment	Debt to capital	Sales per employee	R&D (% of sales)	Capital expenditures (% of sales)	Foreign sales** (% of sales)	Rank
5.1	10.0	21.4	17.2	19.7	145,322	6.6	10.3	47.8	12/90
0.2	2.2	13.9	5.2	62.5	124,041	7.2	3.6	96.0	12/90
21.9	14.6	27.5	27.5	0.0	1,111,841	NA	NA	71.0	3/91
953.0	1.8	NA	NA	NA	136,320	NA	NA	31.0	3/91
-174.5	-1.6	-10.0	-2.2	77.7	105,742	5.9	5.3	44.0	12/90
-34.6	4.2	NA	NA	NA	194,822	NA	NA	23.0	12/90
9.1	4.6	9.0	5.0	44.0	195,225	6.4	11.6	18.2	3/91
-77.6	0.9	3.7	0.7	80.4	263,646	3.6	7.3	36.7	12/90
-70.9	2.1	6.9	1.7	75.8	111,336	1.5	3.1	21.3	12/90
0.3	3.5	13.8	11.3	18.0	101,905	3.2	3.7	26.5	7/90
86.6	1.1	5.7	1.7	70.3	131,246	5.5	6.2	49.6	12/90
12.5	4.3	12.1	7.1	41.0	91,398	4.8	6.3	27.8	6/90
6.7	5.3	21.3	16.1	24.3	98,805	3.5	4.4	NA	12/90
-20.9	2.5	10.9	5.9	45.7	108,056	3.8	7.2	31.2	12/90
14.5	5.1	12.4	5.8	52.7	180,737	2.7	3.6	31.5	12/90
27.4	4.8	10.4	7.3	30.4	644,745	NA	5.7	41.3	6/90
29.1	4.2	19.5	19.1	2.1	132,754	3.4	5.7	47.9	3/91
-12.5	3.7	13.7	7.5	44.8	116,664	5.8	5.5	38.8	12/90
-4.7	7.0	6.5	5.9	10.3	112,574	4.9	7.7	52.7	3/91
-10.1	4.6	11.9	9.1	24.1	150,697	6.6	8.9	79.5	12/90
105.2	5.0	19.9	19.0	4.3	170,656	3.0	5.7	58.3	12/90
77.0	4.2	NA	NA	NA	144,802	NA	NA	65.0	3/91
2.2	9.4	16.0	12.9	19.7	123,222	8.6	11.1	59.3	12/90
-51.0	2.8	9.7	4.0	58.7	157,473	3.9	7.4	43.6	12/90
8.7	8.4	16.9	6.9	59.2	119,312	1.5	18.8	16.6	12/90
NM	-25.2	-151.5	-60.7	59.9	123,722	8.9	6.1	52.5	6/90
-6.9	5.8	14.1	8.9	36.9	278,180	3.6	13.4	54.3	12/90
82.7	4.5	12.0	8.5	29.0	214,638	12.2	8.6	57.1	6/90
33493.4	4.9	17.4	9.4	46.0	63,505	4.3	4.2	35.3	6/90
59.3	2.6	NA	NA	NA	311,659	NA	NA	NA	3/91
20.8	2.7	NA	NA	NA	317,248	NA	NA	62.0	3/91
4.3	8.1	20.5	13.9	32.1	102,760	3.1	4.1	36.1	9/90
-62.8	0.2	NA	NA	NA	189,311	NA	NA	42.0	3/91
-156.8	-0.6	-2.0	-0.7	63.2	396,835	4.7	4.9	78.7	3/91
14.7	6.5	13.0	4.5	65.1	106,725	3.4	10.1	23.4	12/90
20.3	8.5	13.4	12.6	6.2	241,202	14.4	14.1	47.9	12/90
2.6	1.8	5.0	3.0	40.3	131,840	8.3	7.5	41.9	12/90
-7.1	5.2	11.7	7.5	36.1	99,619	4.6	10.8	50.0	3/91
4.8	3.2	NA	NA	NA	403,811	NA	NA	5.0	11/90
0.2	2.5	12.0	5.2	56.6	227,972	2.1	NA	45.2	12/90
31.3	9.0	NA	NA	NA	98,198	NA	NA	28.0	3/91
NM	1.7	7.8	3.0	61.4	134,128	3.8	2.5	21.8	12/90
NM	-14.7	NM	-28.3	134.7	219,994	2.6	1.4	98.4	3/91
3.0	6.5	10.1	8.6	15.2	170,618	13.6	16.1	55.6	9/90
-7.2	1.0	NA	NA	NA	126,797	NA	NA	57.0	12/90
-5.9	2.0	7.7	7.0	9.5	118,132	2.9	5.4	59.8	12/90
-57.8	0.8	NA	NA	NA	519,531	NA	NA	NA	3/91
-7.8	5.7	NA	NA	NA	251,782	NA	NA	47.0	3/91
-6.8	3.9	NA	NA	NA	201,386	NA	NA	17.0	3/91
NM	0.2	0.6	0.3	44.0	116,621	7.5	2.3	32.4	12/90

The ELECTRONIC BUSINESS International 100 is an exclusive report by ELECTRONIC BUSINESS magazine on the 100 largest publicly held international computer and electronics manufacturers. The listing was derived by analyzing company financial statements, 10-K and 20-K reports, and annual reports, as well as through interviews and estimates by the editors

The hot WAN manager market attracts a crowd

More than 100 vendors of wide-area network management products vie for a share of an embryonic market that could surpass $2 billion by 1995

By Dwight B. Davis

Not many vendors have the luxury of tens of thousands of users begging for a broad new category of products. Among the few so privileged are suppliers of management systems for computer networks. As the number, size, and importance of computer networks grows, the demand for tools to monitor and control the communications complexes has reached a frenetic pitch.

Even "we can't get all the tools we need to manage the network," complains Neil Evans, general manager of MIS and corporate services at Microsoft Corp. of Redmond, Wash., the software giant that sells local area network (LAN) software. It's worldwide network includes more than 50 sites linking more than 22,000 PCs. Rather than using a single integrated management system, Microsoft's computer center is forced to employ an unwieldy collection of management packages to monitor different sections and functions of the network.

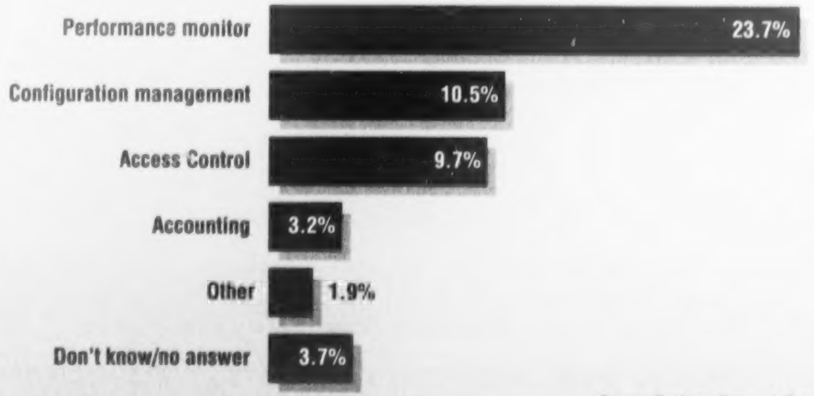
Robust demand and a wide assortment of products have made network management "the most dynamic area in networking today," contends Jerry McDowell, principal networking analyst at San Jose-based Dataquest Inc. Last year, U.S. sales of network management systems totalled $687 million, according to Dataquest but are projected to approach $1.3 billion by 1994. Worldwide sales of network management products will hit $2.25 billion by 1995, predicts Todd Dagres, director of data communications research and consulting at the Yankee Group in Boston. Network management expenditures by MIS departments at *Fortune* 1000 companies are expected soar 28% annually, he adds.

The dramatic growth forecasts are due, in part, to the relatively low market penetration of network management products. Although several analysts acknowledge a lack of penetration data, they agree that the vast majority of local area networks have only rudimentary management facilities, if any. When, and under what circumstances, a computer network needs management tools varies. The operative factor is not the number of nodes or geographic spread of a network, but the nature of the information traversing it, explains Christopher Baum, associate editor and analyst with Datapro Research Information Services in Delran, N.J. The more valuable the data, the more likely it is to find a network management system to monitor it, he notes.

"Internetworking" the numerous local area networks within large companies represents the condition most worthy of network management and the fastest-growing part of the market. Interconnected LANs

Rating the LAN environment

What are the most important issues in managing network information? (Based on *Fortune* 1000 user survey; percentage of respondents)



Source: Business Research Group

may be physically close or widely separated and may support a wide range of different devices, network operating systems, and communications protocols. Corporations with a diverse collection of networks want a single window into the entire system—an integrated network manager. Only recently have network management systems begun to address that need, and the more than 100 vendors serving the market have a long way to go to fully implement the users' goals.

Network management systems are essentially software products, although some are bundled in a workstation or personal computer. Bundled systems typically are priced from $10,000 to $20,000. Software-only packages exist for virtually every type of computer platform, from PCs to mainframe computers. For large, companywide management systems, the annual software licensing fee can exceed $100,000.

Many products monitor only the physical network links and devices, detecting faults, depicting the network configuration, and informing managers, for example, of data traffic volumes and device response times. Other management functions can include everything from maintaining data security to distributing software across the network.

Most users acquire their first network management capabilities as part of a LAN operating system. Novell Inc.'s NetWare, Banyan Systems's Vines, and Microsoft's LAN Manager, for instance, perform rudimentary management tasks as part of their feature suites. Most suppliers' systems fully monitor only their own devices, although some are designed to be company-wide systems, or "managers of managers."

Only a few vendors have tackled multivendor/multiprotocol network management for an entire corporation, ultimately the most lucrative market. IBM claims to lead the companywide network management market, with about 10,000 installations of its NetView software residing on its mainframe and midrange computers. "We have a whole family of network management products, of which NetView is just one," says Bill Warner, director of network management at the company's Networking Systems group in Research Triangle Park, N.C., "and we're well down the road to offering integrated network management."

Bill Warner, of IBM's Networking Systems group

Some analysts dispute IBM's claim of offering integrated network management. They say that most deployed NetView systems are used to manage only IBM networks using the company's proprietary Systems Network Architecture (SNA) protocols. In line with an industry trend to support industry-standard network management protocols, IBM is broadening NetView's repertoire, according to Warner.

Other companywide management system vendors include Digital Equipment Corp.'s DECmcc manager and AT&T's Accumaster Integrator, but the two management platforms that have garnered the broadest acceptance are Hewlett-Packard Co.'s OpenView Network Node Manager and Sun Microsystems Inc.'s SunNet Manager. A variety of network management vendors use the HP and Sun platforms as foundations for their own specialized products. In addition, Cabletron Systems, Cisco Systems, SynOptics Communications, Vitalink Communications, and other hot companies selling hubs, bridges, routers, and other gear for LANs, have network management products as well.

Both OpenView and SunNet Manager support the Simple Network Management Protocol (SNMP), the most popular standard for defining how management data is packaged and transported over a network. As of July, HP's net management systems accounted for 24% of the "generic" SNMP managers, and Sun's for 17% of the installed base, according to Mier Communications Inc., a consulting firm based in Princeton Junction, N.J.; no other SNMP manager held more than a 7% market share. Mier defines generic SNMP managers as those that can manage any network devices described in the SNMP Managing Information Base II (MIB) specification, as well as any third-party MIBs written to conform to the SNMP specification. Mier forecasts that sales of generic SNMP managers will be $89 million in 1992 and will reach 50,000 units and $495 million in revenue by 1995.

SNMP was developed to manage TCP/IP (Transmission Control Protocol/Internet Protocol) networks. As with TCP/IP itself, SNMP is a communications protocol that evolved out of the research community that uses the federal government's Internet (formerly ARPANET) network. Competing with SNMP—albeit weakly to date—is another network management protocol called the Common Management Information Protocol (CMIP). CMIP was developed under the auspices of the International Standards Organization (ISO) and is used to manage networks that adhere to ISO's Open Systems Interconnection model.

SNMP lacks some of CMIP's features, and it isn't a recognized international standard, but networks employing ISO-standard protocols are relatively rare due to the success of TCP/IP, the "dominant" transport protocol used on LANs today, says Yankee Group analyst Dagres. In addition, he estimates, as much 30% of the internetworking traffic over wide area networks is TCP/IP based. Consequently, virtually every management system vendor already supports SNMP or is

may we *focus*

your attention on

advanced

telecommunication ?

COTE d'AZUR

Côte d'Azur planners have seen to it that we became one of Europe's most important pilot regions for R&D and production of telecommunication products and services. The cross-fertilization brought about by the presence of major industrials (DEC, IBM, AEROSPATIALE), world-class research, standardization and training organizations (the International Center for Advanced Communication, the European Telecommunications Standards Institute, THESEUS), major telecommunications services users (AIR FRANCE, SITA, AMADEUS), and thousands of enthusiastic students in our universities cannot be duplicated elsewhere. Add to this the fact that every conceivable new telecommunications technology is offered to facilitate business activity : ISDN, networking on an international level, the latest in voice, data and image transmission techniques, satellite earth stations and thousands of kilometers of fiber optic cable to ensure faultless transmission and reception. If the world is a global village, the Côte d'Azur is squarely at the center of it. Which means that since telecommunication is a more important part of life than ever before, the Côte d'Azur is a more important part of life than ever before. Because aside from the natural beauty around us, there's a beauty and richness of communication such as it has never existed before. Being on the leading edge is the beauty of our business.

MULTICOM

If you like to receive more information on the industrial, scientific and technological aspects of the Côte d'Azur, please complete this coupon and return it to Mr Thierry Martin, General Manager of Côte d'Azur Development.

EB 4-91

C.A.D.
COTE D'AZUR DEVELOPMENT
The Côte d'Azur Economic Development Agency :

10, rue de la Préfecture
B.P.142 - 06003 Nice Cedex
Tel.: (33) 93 92 42 42
Telex : CADELEX 470134 F
Fax : (33) 93 80 05 76

Company
Addres
Mrs, Mr
Tel

scrambling to do so. Most also intend to support CMIP as well, but SNMP's proliferation has slowed user demand for the international standard.

"The explosion of TCP/IP since 1988 took us by surprise, but we have acted quickly to support it and SNMP," says Tony Viola, network management marketing manager at Digital Equipment in Merrimack, N.H. DEC expects CMIP and other ISO protocols to eventually dominate the networking marketplace but, for now, SNMP vendors are serving as the "conscience of the industry," Viola says. "The SNMP community's attitude is: If you see a need today, get a product out by Friday," he explains. "That approach is keeping us vendors on our toes as to what functions are needed." Kevin O'Neil, vice president of network research and consulting at the Business Research Group in Newton, Mass., adds that CMIP and other ISO-based standards will grow in popularity but "the process now looks more like a decade-long event."

EVEN IF A CLEAR winner emerges from the SNMP/CMIP face-off, other categories of protocols must also be incorporated into net management. "To build a network management product, you need anywhere from half-a-dozen to 30 standards, of which CMIP [or SNMP] is just one," says William Gilbert, president of the Network Management Forum in Bernardsville, N.J., a consortium of industry vendors and corporate users organized to publish specifications that would allow vendors to build interoperable products.

For the near term, management system vendors will offer products that support a variety of industry-standard and proprietary protocols. "At the moment, we don't have the luxury of supporting a single network management protocol," says Bernard Harguindeguy, product line manager of network management and communications products at Novell in Sunnyvale, Calif. ☐

Time's running out for U.S. connector makers

If 1991 taught vendors anything, it's that the world market is too crowded and too unforgiving for companies that can't think big

By Barbara Jorgensen

Few connector makers will be sorry to see 1991 end—it's been the industry's worst year since 1985. Sales were sluggish throughout Europe and downright terrible in the U.K., where sales are predicted to endure a 15% year-to-year drop. Demand was also lousy in the United States, where the recession choked growth in major connector end markets such as computers and autos. Overall, North American connector sales contracted 3%.

Stir in declining profits margins—U.S. manufacturers tried to raise prices just 2% to 3% but were largely unsuccessful—and you see just how bad 1991 was for connector manufacturers. Gross margins for major U.S. connector makers averaged 34% or the lowest since 1985 when it was 32%, according to market analyst Jerry Labowitz, first vice president at Merrill Lynch.

Market overcrowding was yet another factor. Worldwide, there are more than 1,200 suppliers fighting for a piece of the roughly $18 billion merchant connector market. They can't all survive in the current market conditions, and they won't. Here's the current supplier headcount by region: North America, 912; Europe, 445; Japan, 215; and the Pacific Rim, 370.

"Take it from our customers' point of view," says Norris Tolson, VP for Du Pont's connector division. "They hear company A is closing, company B is closing some of its operations, and company C is restructuring. They'll conclude that the connector industry is oversupplied and cutthroat, and that our price list is good only for drawing pictures on."

This year's only bright spots were pockets of strong growth—in Japan and the Pacific Rim, where sales are expected to finish the year up 22% and 10%, respectively, according to Ken Fleck, of Fleck International in Huntington Beach, Calif.

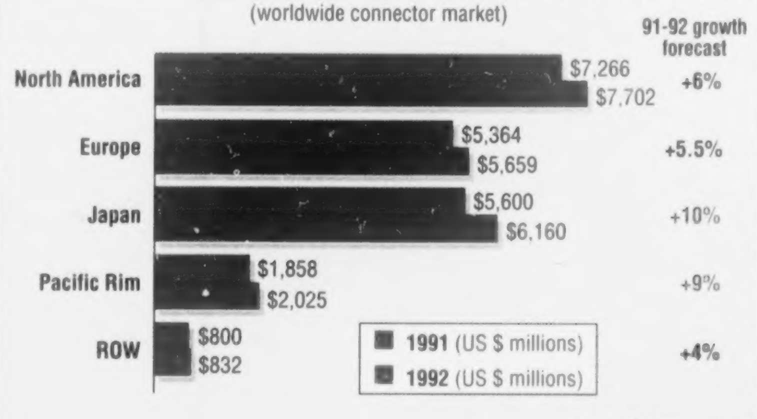
Not surprisingly, connector makers are chasing the business as it moves east. About 41% of Japan's connector suppliers are foreign-based, says Fleck. That compares with 48% in the U.S. and 52% in Europe. Success by foreign manufacturers in Japan remains limited. Of the top 10 suppliers in Japan, only two—Amp and Molex—are not Japanese.

Next year ought to be better for connector makers. How much better isn't clear. Sales are expected to rise 6% in North America and 5% in Europe. That's good, but its not great. Conversely, Japanese sales growth will slow to a still impressive 10%, while Pacific Rim sales growth flattens at 9%. A big opportunity, say observers, is planned work on the telecommunications infrastructure throughout the Pacific Rim region—notably Malaysia, the Philippines, and Thailand.

Globally positioned companies can still prosper—if they sell into those growth pockets—advised speakers at the recent Fleck-sponsored International Connector Congress in Tarpon Springs, Fla. So can niche suppliers with expertise in a few high-end products. Hot product areas

North America still the largest market, but high growth lies east

(worldwide connector market)



Source: Fleck International

identified include fiber-optic connectors, SCSI II interfaces, Z-packs, .050-inch and .025-inch pitch devices, and Futurebus + connectors, according to conference speakers.

The niche formula, says Fleck, has become increasingly successful. During the past five years, he notes, industry giants such as Amp, Molex, and 3M had an average cumulative sales growth of 19.7%. Compare that with 66.3% growth in the U.S. and 195.4% in offshore sales by niche players such as Omni Spectra and Samtech. During the same period, midsize U.S. companies with many product lines but little capital grew by only 1.7%. Clearly, the midsize players are being squeezed out.

Japan, despite its slowed growth, will remain the most robust market for connectors in 1992. Much of the demand will stem from cost-sensitive consumer applications such as camcorders and VCRs. Japan is also a big producer of fax machines and notebook computers, two markets that are expected to boom.

Selling into Japan, though, isn't easy. Obtaining preferred-supplier status can be a prerequisite for doing business with large Japanese companies. To do that, says Ivor Redmonde, director of strategic research for Molex Inc. in Lisle, Ill., connector manufacturers must be able to do the following:

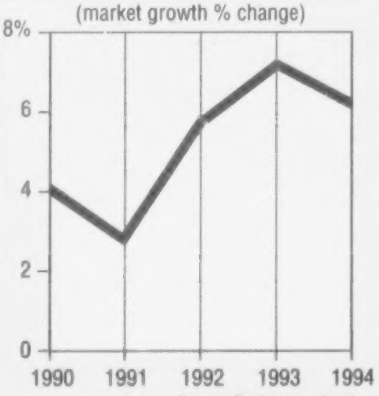
- Supply product to the customer's assembly line within one hour of the specified delivery time;
- Supply reel-mounted product such as capacitors that can be surface-mounted and placed onto boards at the same speeds;
- Provide connectors with 0.020-inch centerline spacing;
- Completely change connector designs to meet new-cycle requirements within 12 to 16 weeks.

Competing with foreign connector suppliers already entrenched in Japan is also difficult. Fleck characterizes the market as closed. That said, opportunities still exist for technologically innovative and cost-competitive U.S. vendors. "You are going to have to bring to the party a technological breakthrough, not a 'me-too' product," advises William Hudson, executive vice president, international, of Amp.

THERE SEEMS TO BE general agreement that Pacific Rim nations comprise an easier-to-penetrate market for foreign connector makers. Not only is the entire region growing rapidly, both as a market

Connector growth in Europe peaks in '93

(market growth % change)



Source: Fleck International

European growth won't surge until 1993

NEITHER European connector manufacturers such as Germany-based Hartig Elektronik nor U.S.-based giant Amp foresee sweeping changes when the calendar flips to 1992. Both say demand will be flat, although industry analyst Ken Fleck forecasts 5% growth in 1992 and 7% in 1993. That's much better than 1991's anemic 2.6% gain.

Whether lifting the barriers between European countries during 1992 will have a dramatic impact on the connector business is still being debated. "There will be some opening up of new markets but no overall greater growth," says Amp chairman William Hudson.

To a considerable extent, access to the European market hasn't been a problem. "I don't see the industry being adversely affected by 1992," says Fleck. "Many U.S. connector manufacturers have facilities in Europe. They are already part of the landscape; but for those with no presence, 1992 may make it more difficult."

Germany and Italy are the only countries that had growth in 1991, based largely on demand from automotive, telecommunications, and consumer electronics. Those pockets of strength are expected to continue. Predicted connector demand in the United Kingdom remains slight.

One nagging question for U.S. manufacturers selling into Europe is how the currency fluctuations will affect business. Though still comparatively low, the U.S. dollar has edged up against most European currencies, making U.S. products more expensive. The exception, of course, has been the United Kingdom, where the dollar remains low. Most forecasts call for continued strengthening of the greenback, which could shift demand away from U.S. connector manu facturers. That is something most Europeans hope happens since Europe still has a considerable trade deficit.

As elsewhere, European buyers are pressing connector makers for low pricing and extended services. Jean-Lucien Lamy, president of Labinal's worldwide connector operation, says customers want suppliers who can design parts to cost, provide worldwide service, JIT, and buffer stocks. Many connector makers, he says, are trying to contain their costs by setting up manufacturing in low-cost labor areas, such as Portugal. ☐

and manufacturing base, but it's also trying to increase the sophistication of the products manufactured there. That shift from low-tech to high-tech manufacturing may create increased demand for high-end connectors made by foreign companies. The rationale is simple. Higher performance computer-based systems will require higher-performance connectors, which are not widely manufactured by PacRim connector makers.

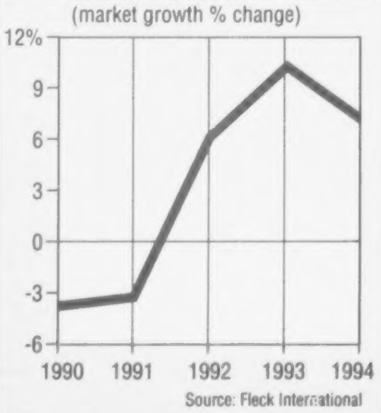
Even here, U.S. vendors run against Japanese influence. Case-in-point: When NEC and AT&T were competing for an Indonesian telecom system contract, AT&T clearly had a price and technology advantage, but NEC—and its Japanese connector makers—got the contract. The reason: Japan invests $2.5 billion annually in Indonesia.

South Korea is another emerging opportunity. On a recent trip there, Molex's Redmonde noted increased activity in the mainframe and telecommunications production, with emphasis on meeting Europe's 1992 "hard" metric requirements. That represents an opportunity to sell 2.0- and 2.5-millimeter connector systems required for those projects, he says, adding the same connectors are likely to be used in the digitizing the Korean communication system.

Taiwan remains a major force in low-end, low-price connectors and has more than 300 connector manufacturers. While these companies will continue to pump out connectors for cost-sensitive applications, there is a growing belief that demand for higher-performance connectors will grow. That's because Taiwan, like Singapore, is making a deliberate effort to climb the technology manufacturing ladder. Government efforts to attract IC fabrication facilities are the most obvious sign of that trend.

Redmonde notes Taiwan is poised to mass-produce 4 Mbit DRAMs and plans to have 0.7-micron CMOS capability by mid-1992. Taiwan also has aggressively pursued the establishment of multi-unit consortia to develop consumer-information equipment for export. As the locally produced ICs are incorporated into locally manufactured systems, demand for high-end connectors will also grow. At least that's the theory. ☐

North American connector market can only get better



Source: Fleck International

North America: Still the biggest market

DESPITE A SHIFT in demand toward the Far East and the ongoing recession, the North American market still accounts for 34.8% of the worldwide connector market. Nearly half of those sales now go to foreign suppliers. Market analyst Ken Fleck projects 6% growth for North American connector sales in 1992, but only a compounded annual growth rate of 4.3% through 1995.

A big question mark is the U.S. recession. When will it end, and how vigorous will the recovery be? No one knows for sure, but one connector industry economist who foresees a brighter 1992 is 3M's John McDevitt. He contends the effects of the North American Free Trade Pact will kick in sooner than many expect and the connector industry will benefit. "It's a market of 361 million people," says McDevitt, "with a GNP a quarter larger than the European Community's. The market for connector manufacturers will be telecommunications, particularly in Mexico."

That market is attracting more worldwide attention. As with Japan, the Four Tigers of the Orient—Singapore, Taiwan, South Korea, and Hong Kong—are beginning to compete with connector makers in North America. One weapon is price. Amp chairman William Hudson claims to see more small companies from Hong Kong, Taiwan, and China selling through agents and competing on price. "Price erosion is a fact," he says, "and, except for sophisticated accounts, many customers will continue to buy on price."

Whether that's sour gripes or a legitimate gripe depends on which end of the food chain you talk to. Connector users aren't complaining. Some foreign suppliers are also winning on service, they say. Once hampered by distance from the customer, foreign manufacturers can now communicate engineering specs and get replies and changes within minutes. "We've underestimated the impact of the fax machine," Fleck remarks. "What's worked for U.S. manufacturers has also worked for the Taiwanese."

On the bright side, North American companies are better equipped than ever before to meet competition. The recession has been a painful tool that has forced needed change. Says Fleck, "U.S. companies are healthier, their costs are under control, there's less overhead and waste, and there's higher productivity, which will help spark even a modest rebound and allow revenue to fall to the bottom line." That, of course, is what they hope. ☐

Buyer rebellion forces change onto ATE vendors
PAGE 107

Tough times slash plant construction 40%
PAGE 95

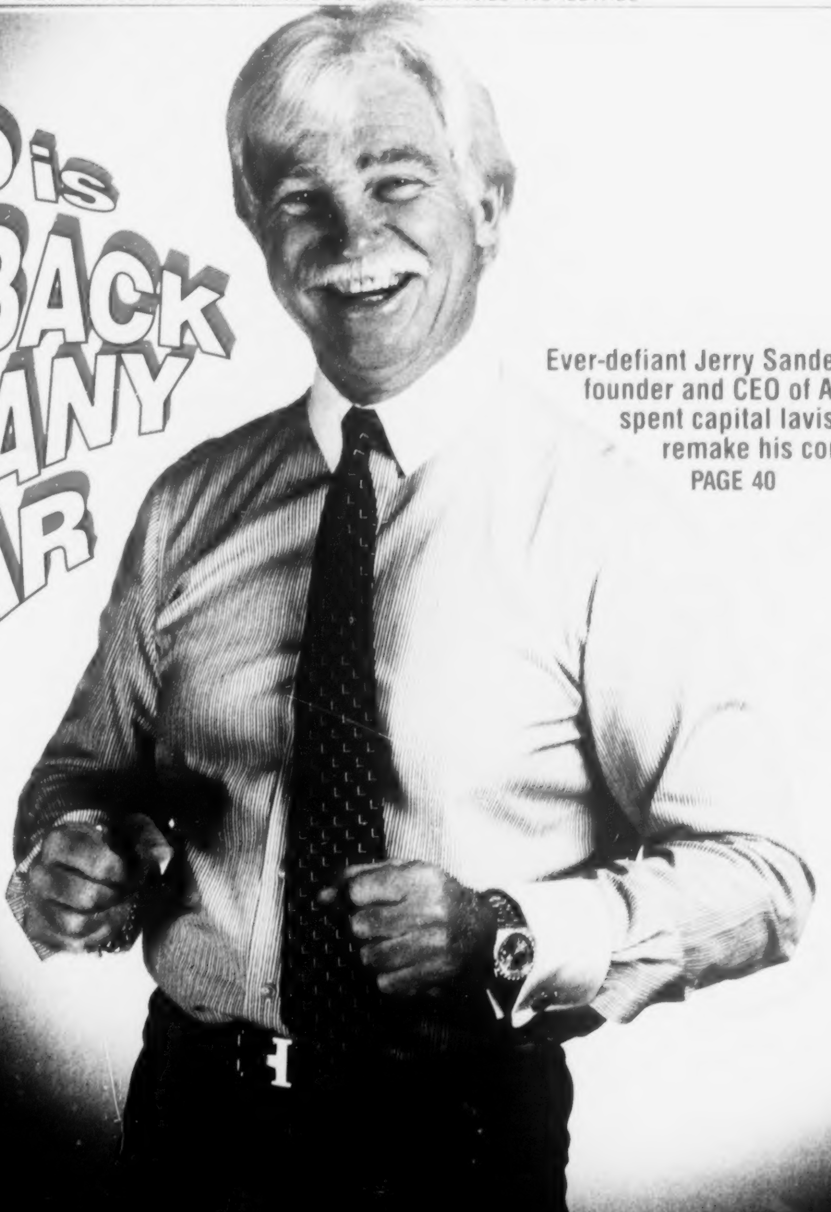
Nokia's merger strategy is unorthodox, but it works!
PAGE 71

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE
NOVEMBER 18,1991

AMD is COMEBACK COMPANY OF THE YEAR



Ever-defiant Jerry Sanders,
founder and CEO of AMD,
spent capital lavishly to
remake his company
PAGE 40

Electronic Business

VOLUME 17, NUMBER 22

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

NOVEMBER 18, 1991

PAGE 40
W. J. "Jerry" Sanders III, founder, chairman, and CEO of Advanced Micro Devices

Cover photo by
Christopher
Springmann

COVER STORY

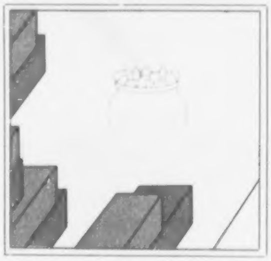
40 Make no mistake: AMD is back!
Advanced Micro Devices Inc. lost nearly $150 million over the past five years, but flamboyant CEO Jerry Sanders guided the company to become a leader in CMOS process technology and microprocessors

54 Etec didn't book a single order between 1988 and 1990
Thanks to a buy-out by the management team and the support of key customers, the sole U.S. maker of direct write e-beam gear returned from oblivion

UPFRONT

Business Trends

11 Harsh reality forecast for chip makers; Contract designers profit from the recession; How to win the time-to-market race; Big isn't better for quality



PAGE 11 SIA remains bullish despite other's pessimism

Companies to watch

31 Phylon Inc. updates communication chipsets; Meridian Semiconductor Inc. clones the 386 and 486 microprocessors; Eteq Microsystems Inc. focuses on high-end chips

Business Barometer

35 Distributors
A temporary stumble for the recovery

36 Communication equipment
Rebound expected in early 1992 after a bad summer

FEATURES

International

71 Brainstorming in the sauna: inside a Nokia merger
Nokia and Technophone combined wildly different R&D philosophies, styles, and cultures to build a new cellular-telephone powerhouse

Economics

83 What will the patent wars cost your company?
Cash-strapped patent holders like Texas Instruments are quick to sue to pick up a buck

Directory

95 Plant site construction gets the deadbolt
During the first six months of 1991, sluggish business conditions have slashed U.S. industrial construction and building by 40%, but there's still plenty of cheap space available

Markets

107 ATE plans for a brighter future— again
After a year of slow growth, ATE vendors must crank out lower-cost products to inject new life into their $3 billion market

DEPARTMENTS

Inside Business

7 Of comebacks and commitment

My View

119 A different kind of selling. A bitter pill to swallow

Company Index

122 Companies covered in this issue

Advertiser Index

123 Advertisers covered in this issue

Viewpoint

124 Nice going Jerry. Now don't blow it!

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Nancy Rutter (San Francisco), Paula Doe (Seattle), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), Xiong Xiaoge, John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Of comebacks and commitment

Senior editor Sprackland (l.), AMD's Sanders (c.), and managing editor Willett focus on commitment

IN HIS new book, *Commitment*, Harvard Business School professor Pankaj Ghemawat creates a new model of business strategy. Forget about "success factors" and probability analysis, he writes. A company stands out in its industry because of a commitment to a particular market, technology, or sales strategy.

Ghemawat cites Wal-Mart, Honda, and Lockheed, but he could just as well have been writing about Advanced Micro Devices and its colorful CEO, W. J. Sanders, the subject of our cover story. Sanders's commitment to submicron technology, reports senior editor Teri Sprackland, has withstood the strain of a $200 million-plus R&D budget and legal battles with Intel for the right to market 386 chips. Today, with sales of those chips booming and profits replacing losses, Sanders's choice seems to have been justified.

Semiconductor equipment producer Etec, meanwhile, is committed to another important idea: the power of partnerships. Cherished traditions of independence have made it a tough sell in America, but that's getting easier as U.S. chip makers continue to take it on the chin from foreign conglomerates. The only U.S. player in its market in 1989, Etec had little to lose by trying a new approach, reports West Coast managing editor Hugh Willett. Sales were all but nonexistent, as was employee morale. Etec managers negotiated a complex buyout deal that combined their technical expertise with equity investment from several industry leaders. Result: a $70 million climb in sales and a chance to keep important technology alive and well—at home.

AMD and Etec clearly illustrate that "commitment" is more than a buzzword. It's the indispensible starting point for any company out to capture the title "Comeback Company of the Year." ☐

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1991 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140. air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $15.00 (USA, Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

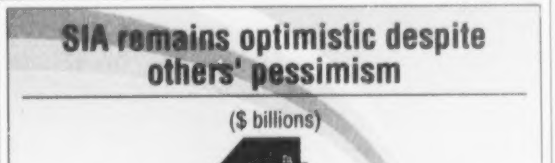
BPA ABP

SEMICONDUCTORS

Chip market reality sets in

HIGH DOUBLE-DIGIT growth rates in the semiconductor industry, once considered its birthright, are likely to be a thing of the past. Chip makers are going to have to adapt their business plans to allow for profitability with growth rates of about 10%, industry watchers say.

Although both the Semiconductor Industry Association (SIA) and Dataquest recently forecast chip sales growth in the low teens for 1992, many observers think the chip business won't make those numbers. An unexpectedly poor third quarter has shaken confidence in an industry upturn soon. "Our sales dropped so precipitously in July that we wondered whether our phone lines were working," quipped one industry participant.


SIA remains optimistic despite others' pessimism

Source: Semiconductor Industry Association, World Semiconductor Trade Statistics Committee

"A lot of industries would be very happy to see 10% growth, but in the chip industry, that's considered a recession," says Dean McCarron, VP of market research firm In-Stat. "Companies are going to have to adjust to a new set of realities as the industry matures."

That means forging new business relationships, targeting new products, and aggressively seeking overseas growth markets. Partnering among chip companies will allow them to share risk and reduce overhead. Chip makers will also be forced to pay more attention to the needs of their customer's customers—the end-users.

Many of the trends aren't new, they're just accelerating. Geographically, for example, growth rates remain stronger in Asia than in the other areas of the world. MOS microcomponents continue to grow faster than bipolar products, according to Dataquest, and BiCMOS, although important and growing, is still dwarfed by CMOS demand.

Here's a quick market outlook. Demand for microcontrollers used in consumer and telecom products in Europe and Japan is strong, while MPUs suffer from soft PC demand. The memory business remains in turmoil as DRAM prices erode, as bit consumption growth remains lackluster, and as fast static RAMs become a commodity.

Adjusting to the current sluggish demand and the emerging slow-growth reality isn't easy for chip makers. The industry is maturing.

- It's much harder to move a $50-plus billion industry up a steep growth curve, notes Larry Hollatz, assistant vice president for technology of NCR Corp.'s Microelectronic Products Division;
- Jerry Sanders, CEO of Advanced Micro Devices, says it's time to stop assuming the industry can grow its way out of problems.

Dataquest forecasts the 1992 semiconductor sales rate at 13.5%. That's not much different from the 13.7% growth forecast it originally made for 1991 worldwide semiconductor sales, which it has since reduced to 9.3%. Dataquest blames unanticipated currency fluctuations for the revision. The SIA predicts total semiconductor sales worldwide to grow 9.8% this year, to nearly $55.5 billion, and then 14.5% in 1992, to nearly $63.5 billion, as the economy moves into recovery. In-Stat is more pessimistic—some would say realistic. It was first to forecast 1991's disappointing performance, and In-Stat anticipates no end to the current recession. In fact, it predicts growth rates around 10% for the worldwide chip industry in 1992.

—By Teri Sprackland in San Jose

SEMICONDUCTOR EQUIPMENT

Small U.S. companies rate high on customer service

DESPITE NUMEROUS reports to the contrary, the small U.S. semiconductor equipment manufacturer isn't dead yet. In fact, its demise may be greatly exaggerated. Service is now the number-one criterion among equipment buyers, and small U.S. companies are turning terrific service into a competitive weapon. At least that's the gist of VLSI Research Inc.'s annual equipment customer satisfaction survey.

Complaints about the service from bigger IC equipment vendors—most

1990's top 10 customer-rated IC equipment companies

Company country	Sales* ($ millions)
1. **Advantest** Japan	$423
2. **ASECO** U.S	12
3. **ESEC** Swiss	30
4. **Hewlett-Packard** U.S	90
5. **Novellus** U.S	67
6. **Lam Research** U.S	135
7. **Teradyne** U.S	218
8. **LTX** U.S	166
9. **KLA Instruments** U.S	153
10. **Eaton** U.S	141

*Semiconductor equipment sales only

Source: VLSI Research Inc.

of which are Japanese—were plentiful, while smaller companies drew praise. Smaller U.S. companies are trying harder to meet customer service expectations and to compete against larger organizations' financial muscle, says VLSI president Dan Hutcheson.

Three U.S. companies were the only newcomers to the 10 top-rated equipment manufacturers, Hutcheson notes. The trio include Hewlett-Packard, Eaton, and Novellus. The latter two, with revenue of $141 million and $67 million, respectively, can be counted as small. Eaton, said one respondent, "is genuinely concerned with meeting our needs and helping us achieve our current and future goals." Eaton's rating in process support went up 22.41% from 1989 to 1990; Novellus's rose 20%.

It should be noted that 1990's top-rated equipment vendor, Advantest, is Japanese; but with annual revenue of $423 million, it is two or three times larger than the other nine.

For many large equipment vendors, being remote from their customers has hurt their service rating. One reason: As Japanese companies grow into large international concerns, they no longer release their first-generation products in Japan only and then iron out problems before shipping new products to the United States. As a result, customers may receive imperfect new equipment, and they say the long service pipeline to Japan is an obstacle to solving problems.

Don't get giddy over this news. There's still a distinction between service/support and reliability. Improvements in equipment have virtually eliminated uptime as customers' main concern. Big companies often do well on reliability. "The big battlefront now is service: How do your front-line people handle customer comment and contact," says Hutcheson. "End users are vehement in their gripes about poor service, coupled with a substantial number of gripes about 'arrogance' on the part of suppliers," he says. Wafer process companies, in particular, have some irate customers, according to the survey.

—By Teri Sprackland in San Jose

EXPORTS

Foreign-owned electronics: Why aren't you exporting?

WHILE U.S. electronics companies are scrambling like crazy to export, the U.S.-based subsidiaries of foreign-owned electronic companies are not. That is different from patterns in other industries where the drive to make a buck has also prompted aggressive exporting across the board. U.S.-based production by these foreign-owned companies has also *not* displaced imports to the U.S. by their parents.

The chemical and auto industries are benefiting from the foreign buying binge of U.S. companies during the 1980s. Production from U.S. affiliates of foreign multinationals has displaced imports from the foreign parent into the United States. Also, the transfer of new technologies and management techniques through the foreign-owned affiliates is forcing domestic-owned companies to be more competitive, resulting in more exports from the United States.

This is not the case for the electronics industry according to a study by economist James Orr of the Federal Reserve Bank of New York. "Despite the [electronics] affiliates' competitiveness in the domestic market over the 1980s, their effect on industry performance and export expansion has not been substantial to date," says Orr. These foreign-owned affiliates haven't been a strong source of new capital spending in the industry, and due to electronics investments in developing countries and outsourcing by U.S. producers, Orr doesn't expect the import boom of electronics products to abate either.

Despite reluctance by U.S.-based foreign-owned subsidiaries to jump into the export market, the contin-

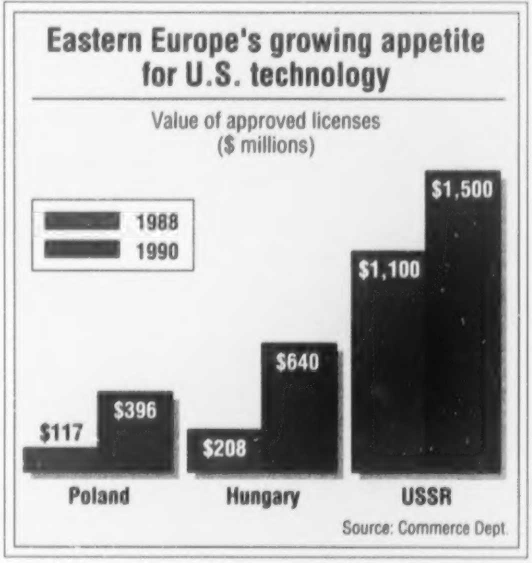
Foreign affiliates sell more, invest less

- Sales from foreign affiliates in the U.S. accounted for over 13% of all domestic electronics production in 1988, up from 9% in 1980
- These affiliates owned 13% of all electronics industry assets located in the U.S. in 1988, up from 10% in 1980
- Foreign-owned companies' share of total electronics industry capital spending fell over the same time, to around 8% in 1988 from nearly 10% in 1980
- Although the U.S. domestic market for electronic equipment doubled between 1980 and 1988, imports more than tripled over the same period. Sales of the U.S. affiliates of foreign companies grew two and one-half times

Source: James Orr, Federal Reserve Bank of New York ued low U.S. dollar is expected to prompt U.S.-owned manufacturers to push into foreign markets.

—By Elizabeth B. Baatz

MARKETS



Source: Commerce Dept.

An easing in U.S. export restrictions coupled with economic reform in Eastern Europe is feeding the growing demand for Western technology. The value of licenses for sales of computers, aerospace products, and other high-tech goods rose 78% from 1988 to 1990 in Poland, Hungary, and the U.S.S.R.—a trend that should continue at an even greater rate in the coming years.

—By Elizabeth B. Baatz

COMPETITIVENESS

Contract designers make the most of the recession

CONTRACT DESIGN companies tend to profit from others' misfortunes. So as the recession hacked away at most electronics manufacturers, business for design contract houses boomed. Stratos Product Development, for example, grew 58% in the past year to more than $3 million. Nebula Corp. grew from about $500,000 to about $2 million in that same time.

That's typical in a down market when layoffs cull design expertise from many companies. Conversely, contract designers may be worth keeping around even when things get better. Some, such as Ideo Product Development, have expanded services to become more broad-based and experienced. Ideo is the product of a four-company merger that brought together 125 specialists from disciplines as varied as electronic design to manufacturing engineering.

Many customers have been happy with what they've seen. "Stratos did an excellent job of blending elegance and functionality into our electrostatic plotter," says John Higginson, an engineering VP with Raster Graphics.

Why the success? Because contract designers offer competent engineering without the overhead of full-time employees—or the wasted time. According to a study by Arthur D. Little, engineers spend 35% of their time actually designing new products. "When we finish a project, we just fly away until you need us again," says Stratos CEO Allan Stephan.

Companies looking to contract should look for experience, breadth of expertise, and contractors who cannot be hired away at a moment's notice. In tough times, insiders caution, many a laid-off engineer has a "consultant" sign outside his door. Look for how much repeat business they get to make sure you don't end up with a half-finished, poorly conceived product design.

As for the future, contract designers remain bullish. "It's true we do well in a recession, but it's also true that customers need help in good times to get more products out in shorter market windows," says Jeff Pollak, a Nebula sales engineer. "The only time that is really bad for consultants is when the industry is flat and predictable, and that almost never happens."

—By Peter Burrows

PRODUCT DEVELOPMENT

Employee empowerment wins time-to-market race

DON'T UNDERESTIMATE employee empowerment. A group of electronics companies found it was a major factor in slashing time-to-market (TTM) by an average of 58%.

Disciples of product development and quality management have been espousing the empowerment philosophy for years, but a recent study by Rosenau Consulting has turned up some pretty powerful benchmarks.

"Some companies could get products out faster by handing over the process to their employees," says Milton Rosenau, president of Rosenau Consulting. "If you give workers the power to violate rules, they'll come up with some creative methods that work."

Rosenau studied 18 electronics companies, some of which reduced TTM by as much as 75%. Among them was Warner Electric, whose clutch brake got to market in 36 weeks, down from 36 *months*.

Does faster TTM translate into higher profits or superior products? It depends on the market you're in, says a consultant at McKinsey & Co. In a high-growth market such as consumer electronics, shipping a product six months late can drag profits down by as much as 33%. The impact in a slow-growth market with long

Some reported TTM reductions

Company /product	Reduction in cycle time
Honeywell	
thermostats	75%
IBM	
PCs	73
Allen-Bradley	
electrical contactors	67
Motorola	
pocket pagers	63
Hewlett-Packard	
computer printer	59
Intel	
chips	56
Codex	
communications products	54
NCR	
checkout counter terminals	50
3M	
digital color printers	50
Whistler	
radar detectors	48

Source: Rosenau Consulting

product life-cycles could be a considerably lower 7% drop in profits. Rapidly changing markets are the ones most likely to benefit from faster production.

—By Quang Bao

INTERNATIONAL

Is scaled software pricing a solution to foreign piracy?

PACIFIC RIM countries, often considered hotbeds of software piracy, have a message for U.S. software companies: If you want to reduce piracy, reduce prices. What may sound like international extortion at first blush has generated U.S. interest.

Delegates of the Southeast Asian Information Technology Organization proposed software prices in individual countries be based on GNP, saying the proportional pricing structure would lower the cost of software applications in developing countries and so reduce the incentive to make or buy illegally copied software.

Long-term gains from reduced software piracy would more than make up for revenue lost by lower prices, says Stan Shih, CEO of Taiwan's Acer Inc. That sounds fishy to many software developers.

Shih says the software pricing scheme was initially proposed by delegates from Malaysia and the Philippines, and Shih has brought the plan to the Washington D.C.-based Software Publishers Association, a crusader against software piracy.

Ken Wasch, the association's executive director, called the proposal "an interesting idea" but is skeptical that software price cuts would reduce software piracy, adding that vendors need to cover local distribution costs in their prices.

—By Rick Whiting

QUALITY

Three companies prove big isn't necessarily better

THE DAY AFTER the Malcolm Baldrige National Quality Award announcements, no big bashes were planned at Solectron.

Winston Chen, chairman and CEO of Solectron said, "People are excited here, but it's just business as usual."

Maybe it was treating quality as a "business as usual" activity that contributed the Baldrige sweep by three relatively small electronics companies. Chen, for one, says he's happiest to report that it doesn't take millions of dollars or mounds of excessive paperwork to win.

Contract manufacturer Solectron with 2,000 employees; power-supply maker Zytec Corp. with 700 employees; and cooling device producer Marlow Industries Inc. with just 150 workers proved you don't have to be big to beat the likes of Intel and Texas Instruments. With 106 companies applying for the award in 1991, it was the first year no large manufacturer won. Intel, furious about not winning, indicates it won't enter the competition next year.

Some Baldrige examiners admitted they were tough judges; negative publicity following Cadillac's Baldrige win last year may have contributed to raising the award's standards.

Zytec is getting help dealing with the flood of publicity from the Commerce Department and IBM, its customer and a 1990 Baldrige winner.

MODULAR PCs

Who benefits most from modular PC upgradeability?

A RECENT wave of "modular PC" announcements by Dell, Advanced Logic Research, and Compaq tout value to users, but the real modularity advantage may be to vendors. Other manufacturers should take notice.

In theory, modularity allows users to upgrade by simply unplugging one I/O or memory card and plugging in a newer generation—but users aren't exactly beating down vendors' doors. AST Research reports that only 5% of its installed user base actually took advantage of upgradeability in its PCs but it expects that numberto increase.

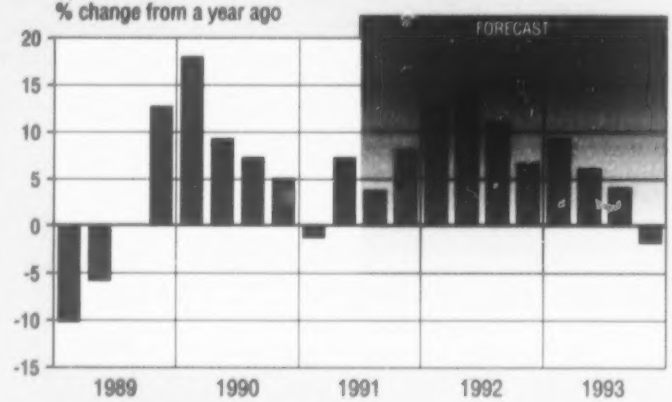
The real savings are to vendors, in cost of design and in inventory. Says International Data analyst Richard Zwetchkenbaum, "Compaq wanted to differentiate through modular design, but it also wanted to cut costs."

Modular standards allow greater design flexibility, and product lines can share modular components across systems, eliminating a good share of product-specific inventories.

The idea isn't new—AST Research, Acer, and IBM have offered PCs with varying degrees of modular upgradeability. Now that gross profit margins are plummeting and product life-cycles are shrinking, however, companies realize modularity offers certain architectural cost benefits that nonmodular architectures don't.

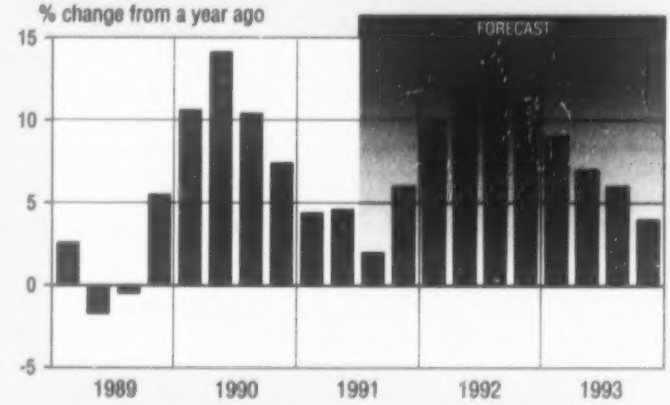
—By David Webb in San Jose

Electronic distributor orders crimped in 1991...



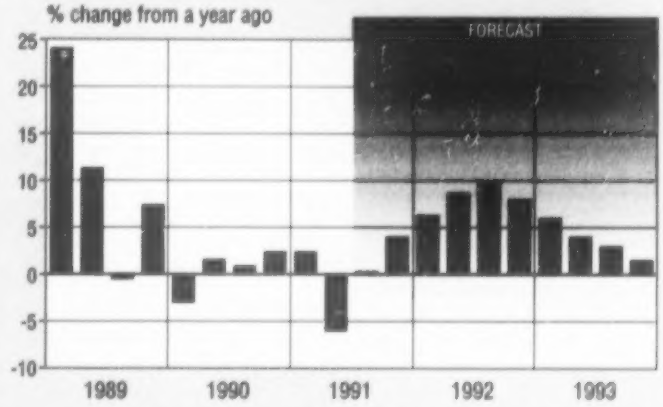
Source: National Electronic Distributors Association; forecast: Cahners Economics

...but the shipments recovery isn't far off track...



Source: National Electronic Distributors Association; forecast: Cahners Economics

...and semis sold through distribution hang on



Source: Semiconductor Industry Association; forecast: Cahners Economics

Distributors' recovery stumbles temporarily

THREE MONTHS AGO Cahners Economics reported that the forecast for distribution was looking relatively rosy. Unfortunately, the summer statistics were disappointing. The severity of the summer slowdown was unexpected, but the predicted recovery is only temporarily on hold until next year.

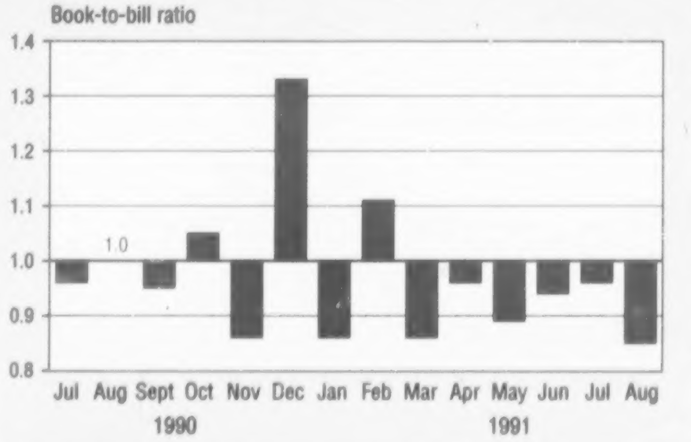
Cahners had predicted new orders would climb 9.6% above year-ago levels in the third quarter of 1991. Now our reading of July and August data from the National Electronic Distributors Association suggests orders rose only about 3.7%. Shipments are estimated to have risen 2% in the third quarter. Statistics from the Semiconductor Industry Association on semiconductor sales made through distributors confirm the sluggish growth trend. These sales fell 3.7% for the three months ending in July. Since distributors tend to be a leading indicator for the rest of the electronics industry, the uneven performance is worrying.

As for the future, we're still sticking by the forecast of stronger gains in the final quarter of this year and the four quarters of 1992. The bottom of the cycle is always the toughest time to call a recovery, but some signs of hope, notably lower interest rates and a robust rate of new product introductions, will help push a modest recovery forward. Also, after two months of a book-to-bill ratio below 1.00, the August ratio anchored in at 1.01, providing a glimpse of better times ahead.

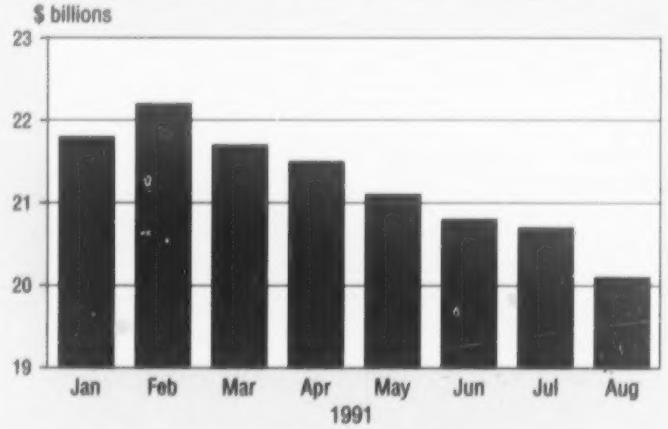
The greatest risk to the forecast, perhaps, is not a double-dip recession. Instead, the risk may be a rebound that is healthier than anyone now has the guts to predict. Cahners Economics forecasts distributor sales will grow 4.3% by the end of 1991, 11.7% in 1992, and 6.5% in 1993.

—By Julie Handelman

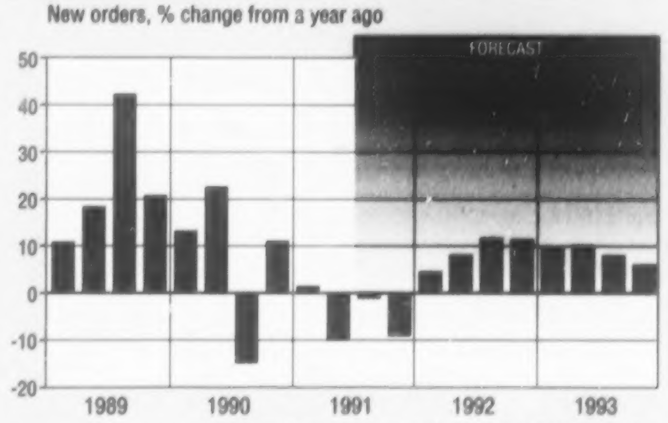
Communication equipment book-to-bill slumps...



...forcing backlogs down drastically in 1991...



...but 1992 will bring a mild recovery



Source: Commerce Department; forecasts: Cahners Economics

Backlogs cushion communication equipment

THE RECESSION ENDED in the second quarter of this year, say 80% of the economists in the National Association of Business Economists. The communication equipment industry, however, still wallowed this past summer in its worst recession since 1986-87. The industry's resuscitation won't begin until the first quarter of 1992.

Volatile as ever, new orders for communication equipment tumbled in August, down 14.4% from July and 12.7% from August 1990. That decline was not an isolated event. New orders dropped below year-ago levels in six of the eight months from January through August.

The industry's book-to-bill ratio hung below the break-even 1.00 mark from March through August. Not in the past two decades has the communication equipment sector experienced such a long six-month stretch of billings outracing bookings. Fortunately, when the 1991 recession hit, U.S. communication equipment factories held backorders totaling about $22 billion—enough to keep shipments at their current level for roughly five and a half months. By August, that buffer had been drawn down by $2 billion, but the remaining stash should keep factories humming through the rest of the winter.

Cahners Economics expects new orders to show losses for the third and fourth quarters of this year relative to 1990, handing the industry its first annual decline in bookings since 1987. By the first quarter of the new year, however, the communication equipment industry will favorably respond to capital spending increases. Industry shipments are forecast to rise 4.3% to $49.2 million in 1991, 6.5% in 1992, and 8.2% in 1993.

—By Madeline Franchi

Etec didn't book a single order between 1988 and 1990

This year the sole U.S. maker of direct write e-beam gear will sell $70 million, thanks to a management buy-out and customer buy-in

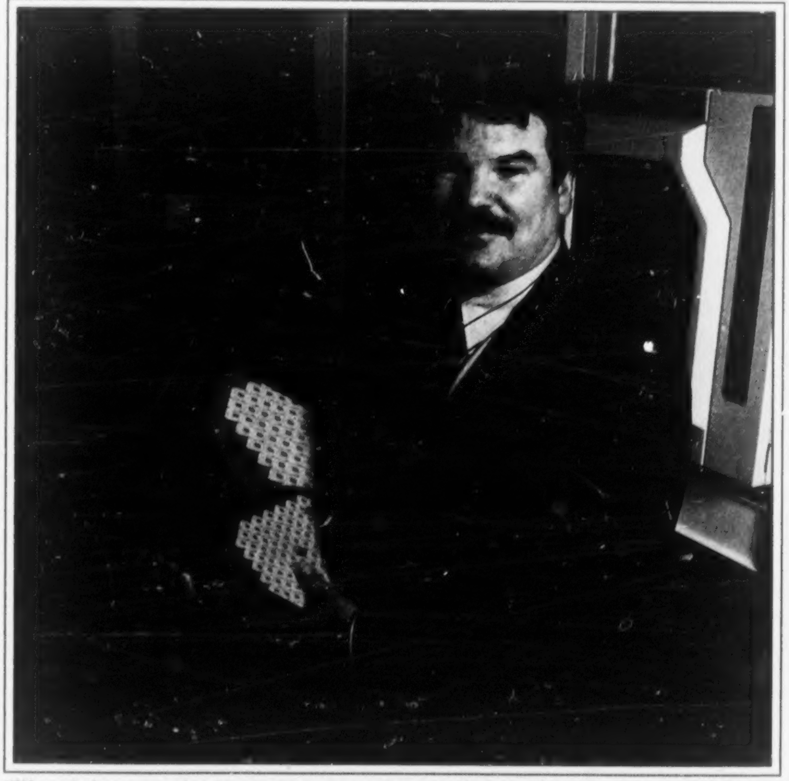
By Hugh G. Willett

Seldom has a company had to climb such a steep slope to make a comeback as the recent return to life of Etec Inc., the Hayward, Calif.-based manufacturer of electron-beam equipment for the semiconductor industry. Once a subsidiary of Norwalk, Conn.-based Perkin-Elmer Corp. (PE), Etec went from prosperity in the mid-1980s to virtually zero sales several years later and then to $70 million in revenue in 1991.

"The company didn't book a single order between 1988 and 1990," exclaims Charles Minihan, Etec's chairman and CEO. Minihan was general manager of Etec from 1979 to 1985 and returned from a short-lived retirement to lead the turnaround.

Etec's rebound is the result of a unique partnership involving IBM, Grumman, Zitel, DuPont, Perkin-Elmer, Micron Technology, the Sematech consortium, and a hardy group of about 60 Etec managers. A buy-out by the management team led by Minihan, with the support of key customers, prevented the company from becoming another casualty in the U.S. semiconductor equipment industry.

Etec's roller-coaster history through several business cycles wore out the patience of its corporate parent, which was essentially an analytical instrument vendor. PE executives had become weary of the semiconductor industry's ups and downs, Minihan says. Although 1987 was a peak sales year, Minihan says the "Wall Street worshipers" at PE began to hunt for a buyer for Etec and several other semiconductor divisions in 1988, less than 10 years after acquiring it. Consequently, morale suffered, customers worried, and sales evaporated. "The employees went through a period of disillu-



"We got six companies to agree to cooperate, negotiated with each of them, and then had to get them all to agree again," recalls Etec president Tom Halloran, "but when it was over, they were really committed to working together"

What a difference a buy-out makes for Etec

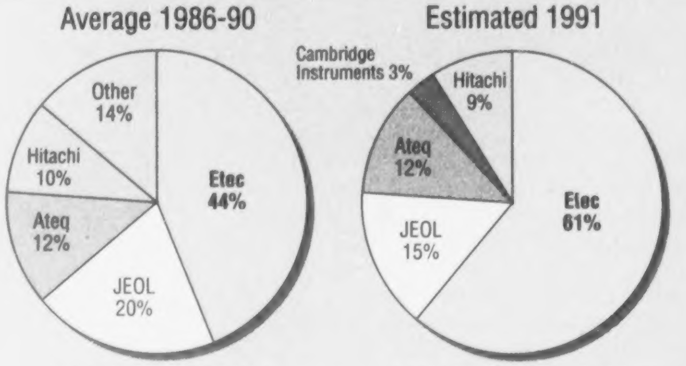
($ millions)

	1990	1991	% change
Revenue	$48.5	$70.0	44%
Bookings	30.0	80.0	266

Source: Etec

sionment that really hurt the company," he adds.

Etec's growing share of the e-beam market


Average 1986-90

Estimated 1991

Total market: $100 million

Total market: $102 million

Source: Etec

The semiconductor industry viewed PE's treatment of Etec with alarm—it was a piece of the complex chip-making puzzle the industry could not afford to lose. Etec is the only U.S. company that makes direct-write electron-beam lithography equipment—it etches circuits directly onto silicon. The technology is considered critical for production of chips at 64-Mbit and higher densities. About a half-dozen manufacturers make direct-write e-beam equipment for commercial or internal use, and most of them are Japanese. The technology also is used to make photo masks, not only for giant companies such as DuPont, but also for small mask shops such as Diamon in Los Gatos, Calif. "Under Perkin-Elmer, Etec wasn't getting the resources to invest in new technology," says Richard Diola, vice president of Diamon.

ALTHOUGH CHIP MAKERS still rely heavily on optical lithography, e-beam technology is important. Etec had delivered more than 130 of the world's 200 installed e-beam systems. Companies such as Diamon that had invested in earlier generations of Etec equipment were worried they would have to go to Japan to find new suppliers. "It was of grave concern to us that this technology stayed in the United States," notes Diola. Adds Peggy Wood, senior industry analyst with Dataquest in San Jose, "It's very important to the industry to have an international balance of that technology."

Etec grabbed 61% of the worldwide e-beam market within 18 months, up from 44% in the beginning of 1990

The loss of resident e-beam technology in the U.S. would have dire consequences for the domestic electronics industry. Optical lithography will not have the precision to deliver 256-Mbit DRAMs by the time of their estimated development in 1994, Minihan contends. By the year 2000, e-beam equipment will be making gigabit DRAMs, and optical lithography will be only a memory, he predicts.

Several U.S. companies looked at Etec but declined to make an offer to Perkin-Elmer. The prevailing attitude in the industry was that it would take too much work and too much money to make the company competitive again, despite its historic strengths. Faced with a dearth of suitors, Etec managers decided to court PE themselves.

After almost two years of complex negotiations, the managers had gathered a group of six corporate investors to support their bid of $39 million in cash and securities in March 1990. Grumman, DuPont, and Micron Technology each invested $5 million for an equity stake in the company, Zitel invested $1 million, and managers contributed an undisclosed amount of cash in exchange for a 17% stake. Their investment—a $6 million note guaranteed by IBM and DuPont, preferred stock, and junk bonds—was used to pay Perkin-Elmer. IBM was given an equity interest in exchange for its loan-guarantee and contributing e-beam technology developed internally. The new technology was needed to put Etec's next generation machines in a leadership position and convince current customers that a technology migration path was in place.

Etec president Tom Halloran, who left Etec in 1987 before joining the management group, says his team pulled off one of the most complicated deals in the history of the semiconductor industry: "We got six companies to agree to cooperate, negotiated with each of them, and then had to get them all to agree again." The arduous negotiations, however, led to a stronger venture. "The difficulty of negotiating the deal turned out to be a plus," explains Halloran. "When it was over, they were really committed to working together."

AFTER THE DEAL was completed Halloran and Minihan wasted no time attacking the company's problems. They immediately visited every customer worldwide to restore their confidence. The pedigree of the returning managers had a lot to do with regaining customer confidence, according to Dataquest's Wood. Customers knew that Halloran and Minihan had direct-write equipment experience, had worked together for years, and were respected by the investors. Halloran and Minihan heard first-hand about

Etec's tattered image and what its customers said it would take for Etec to get back into business.

SIX WEEKS AFTER the deal was signed, Etec had a company strategy tuned to the needs of its customers. Within three months, Minihan and Halloran picked a new management team—including some Etec alumni—more attuned to customer service, and they trimmed the 500-employee roster by about 80 employees. Minihan and Halloran paid particular attention to restructuring middle management, which they say had stagnated. "We shook things up a bit, but we were able to get people back in the mood to succeed," Halloran explains.

After making a forceful and, Halloran concedes, expensive effort to resolve outstanding customer complaints, Etec began to take advantage of its worldwide marketing reach—50 employees in Japan, 30 in Europe, and one in Korea. The company that hadn't booked an order in years managed to sell seven systems—at about $3.5 million to $4 million each—by the end of fiscal 1990.

More importantly, according to John Wiesner, senior VP of research and engineering, customer confidence increased since Etec is developing IBM's e-beam technology to provide systems in 1993 capable of 0.2 micron resolution. IBM's technology also brought in revenue in the form of development contracts from the U.S. Department of Defense and Sematech of Austin, Tex.

Fiscal 1991 saw strong sales in Japan and Korea, generating a $60 million backlog of orders, although the slump that hit U.S. chip makers last year has prevented Etec from further enjoying its leverage as the only domestic supplier of e-beam equipment. Etec claims to have won 61% of the worldwide e-beam lithography market within 18 months of its liberation from PE, up from 44% in the beginning of 1990.

Crucial support on the home front came in the form of a $20 million development contract from Sematech.

A management buy-out, led by Etec CEO Charles Minihan, prevented another casualty in the U.S. semiconductor equipment industry

The contract provides not only funds for technology development, but also allows Etec to work closely with other suppliers and potential customers to provide a solution that is well integrated both upstream and downstream. "I can't overemphasize how important Sematech has been to our effort," Minihan says.

Etec's managers did one of the most complicated deals in the semiconductor industry's history

Partnering with customers and suppliers has become more than a way to raise cash—it has become the central theme to the company's business plan. Earlier this year, Etec formed an alliance with European Silicon Structures to develop equipment using direct-write e-beam technology to speed the production of custom chips. Development alliances have been signed with about a dozen organizations this year, including chip maker Advanced Micro Devices Inc. of Sunnyvale, Calif. Such alliances involve a close working relationship to identify specific challenges, splitting the engineering costs between both parties and developing a solution that fits the customer's needs in a shorter time.

Minihan argues that Etec's partnership strategy is a model for the U.S. electronics industry, which in his eyes is basically a large group of small companies that compete with giant foreign conglomerates—many backed by their governments. The U.S. electronics industry understands technology as well as any other country, he says, but it doesn't have the financing ability to overcome the high cost of capital without some sort of team effort. "U.S. chip makers just can't afford to devote 10% to 15% of their sales dollars to research," Minihan insists. "They have to look for partnerships to help them leverage their investments."

EVEN A WELL-HEELED behemoth can take advantage of the strategic alliance strategy, Etec officials claim. By turning its in-house e-beam technology over to Etec, IBM will get more bang for its R&D buck because the technology is being driven by a larger and more diverse number of players, as well as by the entrepreneurial spirit of the management team. "Big companies such as IBM and AT&T are finally saying, 'Capital equipment is not my area of expertise,'" Halloran notes. "They can help define a new technology, but then it's better to pass it off to a real equipment company."

Etec's challenges for the future include maintaining close customer alliances, developing more partnerships, and improving productivity. Halloran says he wants to improve the sales per employee from 1991's respectable figure of $100,000 to about $150,000 by next year.

The biggest challenge for Etec's managers will be to continue to generate capital for future research investment and to manage it carefully through partnerships, he says. He doesn't want to have to tap the original investor well again. A public offering is a possibility, although not in the immediate future, he adds. ☐

have scored handsomely from the patent wars, others worry that the litigious environment could harm the industry as a whole. Few dispute the rights of companies or inventors to profit from their patents through licensing, but critics contend the high cost of litigation, in both time and money, saps the industry's creative energies and slows down the introduction of new products.

San Jose-based Sierra Semiconductor Corp., which is being sued by Brooktree, is building up a patent portfolio of its own to fight back, according to C. Stephen Cordial, vice president and chief financial officer. "It's almost like the SALT talks," he says. "You need a stockpile of weapons before you can sit down and talk about getting rid of them."

MANY COMPANIES HAVE found that patent litigation can be a double-edged sword. Brooktree, which whipped AMD in court not long ago, is now fending off patent-infringement claims by—you guessed it—AMD. TI, meanwhile, is being challenged on a key semiconductor patent—the famous Kilby patent—by Japan's Fujitsu Ltd. TI, which has signed licensing deals with Fujitsu on other patents, says it intends to sue Fujitsu.

Some analysts believe the Fujitsu dispute could encourage other companies to call TI's bluff, thereby clouding TI's chances of collecting future patent profits. That could hurt the company's bottom line. TI reported a loss of $157 million for the second quarter, due largely to a work force reduction, while earning $74 million in royalties.

Despite the potential backlash, nobody wants to be the first to call a truce. "Litigation isn't the best way to do business, but companies have no alternative," says David Lovejoy, a lawyer at San Francisco's Fliesler, Dubb, Meyer & Lovejoy. "Whatever you have, you play it."

Whoever claims the moral high ground, one thing is clear: The patent battles have hiked the cost of doing business and have changed—perhaps forever—the nature of competition in the electronics industry.

Just ask Brooktree CEO James Bixby. After founding the company in 1983, his new chip-based technology became the industry standard for computer graphics. Competitors such as AMD soon jumped in with similar products and prices plummeted. Over one six-month period, Bixby recalls, prices plunged 40%. Since winning an injunction against AMD, the price erosion has slowed.

In May Brooktree sued Sierra Semiconductor, alleging Sierra's computer graphics products infringe upon three Brooktree patents. The litigation was expensive, but Bixby says it was worth it. "Technology is the lifeblood of our company. If we can't protect that, we're in trouble."

Sierra, of course, sees things differently. CFO Cordial says the attack by Brooktree has forced his company to divert engineering time from developing new products to

U.S. patent wars spark Japanese backlash

THE PATENT WARS started in earnest, according to author George Gilder, when Texas Instruments "exploited its patents by suing everyone in sight." Now some observers fear the strategy will backfire on the entire U.S. electronics industry.

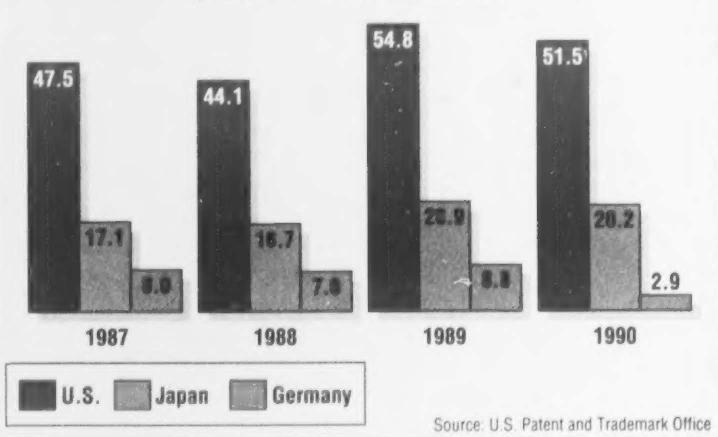
The reason: Japan has reportedly earmarked vast resources to track U.S. patents and beat U.S. companies to the punch. The tactic: Limit the effectiveness of U.S. patents by "bracketing" them with similar Japanese patents, thus forcing U.S. patent-holders to sign licensing deals with the Japanese.

Japan led the pack last year in U.S. patents issued to foreign residents. Hitachi won 40% more U.S. patents than IBM, and the top-four patent winners in this country were Japanese. Some patents, says Gilder, involved "clustering"—protecting a product by patenting unique features rather than the device itself.

Nevertheless, several U.S. patent lawyers say the Japanese knew their way around the U.S. Patent and Trademark Office long before TI launched its patent litigation offensive, and that bracket and cluster patenting are not new. Some argue that mounting global competition would have forced Japan's hand anyway. □

Japan pumps up its patent portfolio

(thousands of U.S. patents awarded)



Source: U.S. Patent and Trademark Office

ATE plans for a brighter future—again

ATE vendors crank out lower-cost products to inject new life into their $2 billion market

By Peter Burrows

This was supposed to be the year the automatic test equipment (ATE) market bounced back. After limping through the late 1980s with annual growth rates of around 5%, analysts expected an upswing in ATE sales to support manufacturers' new generation of hard-to-test components and systems. Systems-on-a-chip would require high-performance VLSI logic testers. Sixteen-megabit DRAMs would require racehorse memory testers. Chips for document imaging and signal processing would require cutting-edge mixed-signal testers. Double-sided, multilayer boards, sometimes populated with multichip modules and other new package types, would require a new, more flexible brand of board tester.

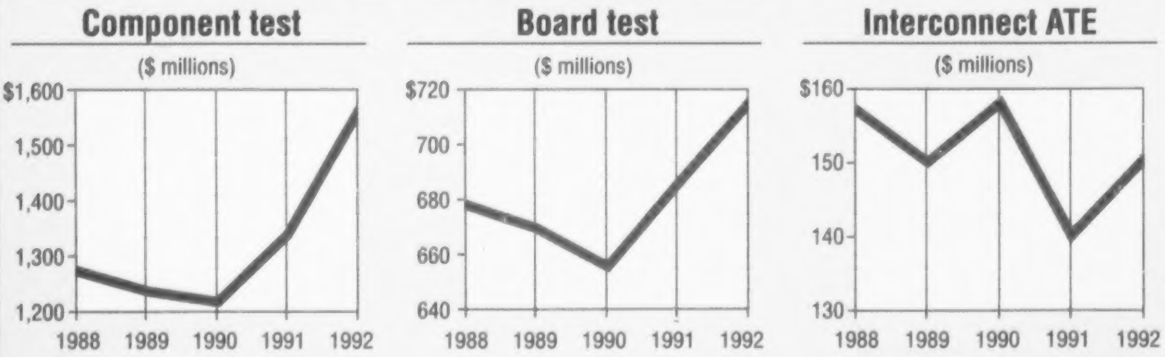
The recession and its hard-to-call recovery have taken much of the air out of that bounce—the $2 billion market should grow just 5.7% in 1991, according to Ken Neff, a market researcher with Prime Data in San Jose. "George Bush is the only one who thinks the recovery is at hand," quips Robert Anderson, CEO and president of GenRad Corp. in Concord, Mass. "With the economy improving so slowly, most customers are content to try to squeeze more out of the equipment they already have."

ATE vendors, by now accustomed to slow growth, have not stood still. Faced with fierce competition and the challenging task of finding ways to test tomorrow's electronic products with today's technology, they have forged ahead with an impressive array of new products. While six of the top 10 ATE vendors suffered decreased sales as recently as 1990, important new products from LTX, Teradyne, Hewlett-Packard, Integrated Measurement Systems, Megatest, Schlumberger, and others should lead to market growth of more than 10% in 1992, predicts Neff of Prime Data. No boom, but better.

The big question is how fast the component test market will grow. Engineering labs are taking delivery of these new testers to help prepare the next-generation devices for market; but while ATE executives had been counting on a banner year in 1992 as these R&D contracts turn into higher-volume production contracts, most have reconsidered and now expect another flat year. Assuming the recovery does pick up steam and a scheduled fab-building spree takes place as planned, component-test equipment sales growth should reach 13%, predicts Neff.

The faltering board-test market is another story. Buffeted by cuts in military spending and falling mar-

Component test paces ATE growth


Component test
Board test
Interconnect ATE

Source: Prime Data

gins as a result of slashed spending by weakened computer-makers, the board-test market will increase by less than 5% this year, after three years of declining sales, according to Prime Data. In response, heavyweights like GenRad, HP, and Schlumberger are developing strategies to expand the reach of their products into the huge world of roll-your-own, rack-and-stack test equipment.

The overall sluggish outlook means at least one more gut-wrenching year of high investment and low sales for ATE vendors. Systems routinely cost $20 million to bring to market and may take five years to be fully accepted, so vendors must maintain R&D investments in the range of 15% of revenue to keep up with the incessant pace of new product complexity, which some analysts say rises 35% a year. As a result, the name of the game in ATE is the same since market growth plummeted in the mid-1980s—hold onto market share until the next market boom. "There's not much else we can do," explains GenRad's Anderson. "We could get real aggressive and try to double our market share to improve our volume now, but its not likely we could do that against strong competitors like Teradyne, HP, and Schlumberger."

Walking that tightrope has not been easy. Many companies have bled red ink profusely while waiting for the next market upswing. GenRad, with revenue of $179 million in 1990, lost more than $100 million over the last six years. LTX Corp. in Westwood, Mass., was faced with monstrous cash-flow problems until Japan's Sumitomo Metal Industries Ltd. kicked in $12 million for about 13% of LTX's equity and $12 million for a 49.5% stake in LTX's Japanese operation in 1990. Armed with the cash infusion, LTX finished the development of high-end mixed-signal and VLSI testers and managed to increase its sales by 34% and its market share by more than two percentage points in 1990—the industry's best performance of the year.

The changing shape of board-test vendors

AFTER THREE YEARS of declining sales and only a modest uptick in sight for this year, it's clear that selling board-test systems as they now exist is not a growth business. This year the market leaders are revealing the shape of things to come.

GenRad, Hewlett-Packard, and Schlumberger Technologies, the top-three vendors of automatic board-test systems, are introducing less costly product lines aimed at the traditional rack-and-stack instrumentation market. Approximately twice as large as the $2 billion automatic test equipment (ATE) market, the rack-and-stack market consists of test engineers who cannot afford, or cannot find, adequate ATE solutions. Instead, they buy nonautomatic instrumentation and measuring devices to integrate into homegrown test systems.

"With the economy improving so slowly, most customers are content to try to squeeze more out of the equipment they already have," laments Robert Anderson, GenRad's CEO

"The key to our future is to grow beyond just ATE," says Robert Anderson, president and CEO of GenRad, which has spent over two years and $15 million on new testers despite having lost money in each of the last six years and more than $6 million in the third quarter of this year. "The rack-and-stack folks have always wanted to be replaced—most customers are tired of being in the test and measurement business."

The new-look products from these companies have remarkably similar features. All are heavily software-based and comply with open standards to make them easier to use for the less sophisticated rack-and-stack user. All feature software links that enable test engineers to work more closely with the designers to ensure that new boards are testable from the start. All feature hook-ups with VXIbus instrumentation—single-boardcomputers that fit into a card-cage and that offer improved performance and efficiency but require little of the cabling of traditional stand-alone instruments that use the VMEbus.

All of these systems are also based on common core architectures. That lets customers use more than one product type in tandem and cuts the vendor's development costs as well. GenRad, for example, recently announced a product for the communications marketplace that will be the core for similar products for the military and other markets once market-specific functionality has been developed.

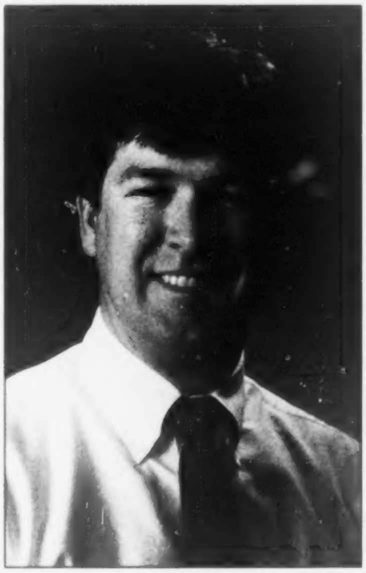
The business formulas behind these new products are also in flux. Vendors are unbundling software and hardware into products rather than shooting for the higher margins of turnkey systems. Service and consulting will become a bigger source of revenue as engineers look for help in testing new boards that feature extensive surface mount technology, innovative package types, and increased density. Schlumberger expects its systems integration business to rise as it helps customers find application-specific instrumentation necessary to round out its core ATE offering. □

Nevertheless, without outside help—or the resources of a broadline parent like HP or Schlumberger—few ATE companies will be able to keep up, says Alex d'Arbeloff, CEO of Teradyne Inc. in Boston. As capital spending shrinks in response to the tighter competition present in most IC, systems, and military markets, the ATE industry is realizing a tough lesson: Maybe the next boom won't be nearly as strong as those in the past.

"We may not like to admit it, but this industry hasn't been cyclical for five years," says Teradyne VP Jim Prestridge. "It's been flat."

TO RESPOND, most ATE companies have been forced to rethink their cost structure to adapt to the new realities. Even market share leaders have been forced to downsize. Teradyne and GenRad had significant layoffs in 1990 and more recently instituted freezes on management pay raises as well as unscheduled plant shut-downs. GenRad reduced its product line and ordered more layoffs during the past few months due to disappointing sales. GenRad and HP initiated partnerships with software companies to reduce their own software development costs. HP has offered early retirement at both its board-test division in Loveland, Colo., and its component test division in Palo Alto. Credence Systems Corp. in Fremont, Calif., laid off 7% of its work force in September. Megatest, in San Jose, laid off employees and outsourced much of its manufacturing to outside contractors.

That new austerity seems to be working, at least for the short term. Teradyne, which lost $21.3 million in 1990, expects to be profitable this year, claims d'Arbeloff. LTX bounced back from a $17 million loss in 1990, including a one-time charge of $14.4 million, with a $6.1 million profit in fiscal 1991. Privately held Megatest, Credence, and HP continue to stay in the black, but just barely. "We need more volume to get our margins where we want them," says Jim Davis, general manager of semiconductor test equipment marketing for HP. The same goes for all.



"Most chip makers are at a transition point—we need to move to new test technologies as new parts come along," says Micron Technology's Marvin Strong

COST-CUTTING ALONE will not return the industry to health, however. For almost a decade, electronics manufacturers have spent less and less on ATE, notes Dan Hutcheson, president of VLSI Research in San Jose, and the trend continues. He estimates that the percentage of capital spending devoted to ATE has shrunk from 12.9% in 1984 to 6.8% in 1990. In fact, many customers are still making due with 10- or 20-year-old technology; Fairchild's Sentry line of logic testers (now owned by Schlumberger) dates back to the late 1960s but remains the single most-used tester in the world, says Hutcheson.

The common reason cited for this tight-fistedness is the exorbitant-sounding prices of the newest generation of ATE. A chip maker will pay up to 80% more for the ATE to test 16-Mbit DRAMs than the price of a tester for a 4-Mbit device. Some electronics executives are getting over their sticker shock, as indicated by the brisk sales of $1 million-plus high-end mixed signal testers by Teradyne and LTX and the continued success of market leader Advantest America Inc. in Lincolnshire, Ill., in selling top-of-the-line logic and memory testers. The reasoning behind the new price acceptance is simple—new test technology is required to both ensure quality and maintain time-to-market as increasingly dense integrated ICs and boards come to market.

Marvin Strong is typical of the buyers resigned to their fate of having to pay more for test equipment. Strong, Micron Technology Inc.'s test manager, recognizes that the Boise, Idaho, company will have to pay a higher price for next-generation memory testers able to test 64 devices in parallel and in less time per device than its current tester, which is optimized to test 16 1-Mbit DRAMs concurrently. "Most chip makers are at a transition point, and we're no different," he says. "We recognize the need to move to new test technologies as new parts and packages come along."

But cost-of-test will not fade as an issue—especially as improved manufacturing techniques drive down the number of faults available to be found. "A million dollars doesn't freak people out like it used to, but they're not willing to extrapolate that number out into the future," says Craig Foster, director of marketing for Megatest. "I don't think anyone will ever get $5 million for a tester. After all, chip prices don't rise every year, so why should ATE prices?"

Megatest, a private company that claims to have made money in 17 of its last 19 quarters, may indicate the shape of things to come in ATE. Along with other fast-growing competitors like HP and Credence, Megatest uses technology to drive down the cost of ATE rather than drive up the level of performance. It incorporated extensive IC integration to cut the footprint—and therefore the price—of its machines almost in half. HP, which is expected to grow its ATE revenue 25% this year, used technology developed in other HP divisions to reduce its price to well under $1 million for its top-of-the-line model. Credence has used lower-cost CMOS circuitry to reach a similar price point, about $5,000 per test pin, compared with $10,000 or more for testers based on the traditional ECL technology.

All these competitors have, for the most part, avoided cut-throat markets for testing high-volume devices like microprocessors and commodity memories in favor of high-growth ASIC and mixed-signal segments, but their success should not be dismissed as nicely executed nichemanship. The experiences of Jerry Moench, product line manager at Advanced Micro Devices Inc.'s fab in Austin, help explain why.

When his test group suggested the company buy a highly-touted $1 million-plus Advantest logic tester for its programmable logic device products, "management told us to think again," says Moench. His group ended up with a $500,000 Credence tester that has helped reduce test times per device by more than 30%. Although a lack of software has increased the time it takes to write test programs, Moench is content with the choice. "If it takes a bit more engineering resource to get there, we'll do it," he says. "There may be a better solution out there, but we have to worry about the economics, too."

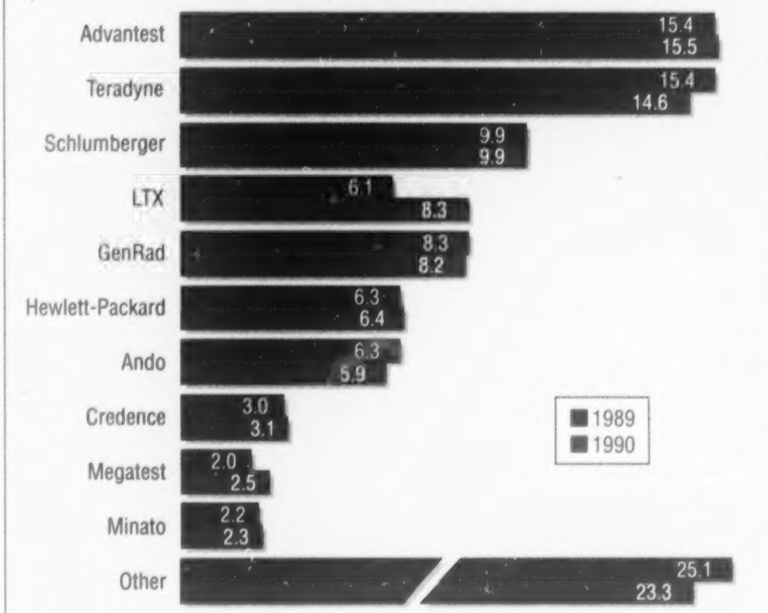
THE CONCERN over the cost of test has also spurred the growth of the test-station market. Pioneered by HP and IMS, these machines were originally designed as front-end tools to help ASIC designers ensure that their designs made sense. Due to their low cost, easy programmability, and flexibility, however, many are now being sold into low-volume production environments and into other traditional ATE applications such as IC characterization and failure analysis. "We want to deliver 90% of ATE's capability for five to 10 times less money," says IMS president Keith Barnes. With less than half the throughput of traditional ATE and with far less functionality, there are big questions as to how far this strategy will take test stations, but Prime Data's Neff and Andrew Rappaport of Boston-based Technology Research Group both predict the $60 million-or-so test-station market could grow beyond $400 million by 1994.

Try as they might to maintain their high-margin products, old-guard ATE players are also finding success in lowering the cost to customers. Analysts credit LTX's comeback on its products' highly modular architecture, which lets customers start small. Market-specific configurations have also proliferated; Teradyne, traditionally weak in VLSI logic testing, made big waves in that market in 1990 with its J971 model. A leap ahead in technology, the machine offers full functionality at a price-per-pin cost of only $7,000—down from about $10,000-plus for the higher throughput of the J953 that preceded it. "If you do the math, the J953 can do more parts, but there's still the sticker price shock factor," says vice president George d'Arbeloff, Alex's younger brother. "Life is just too short to try to educate the world [on the value of high-throughput testers] and maintain performance." While they have no current plans to enter the market, Teradyne executives even admit to watching to see how the low-end test station market shapes up.

"The market seems to agree that we offer our customers extra performance," Alex d'Arbeloff told security analysts last October, "but the market is also becoming resistant to the idea of paying for that performance—which really has been our game over the years. We are now going to have to become the low-cost producer as well as the performance leader." Teradyne is not there yet—and it is not alone. ☐

Battle continues for ATE market share

(% market share)



Source: Prime Data

Fiber to the desktop without the fiber
PAGE 75

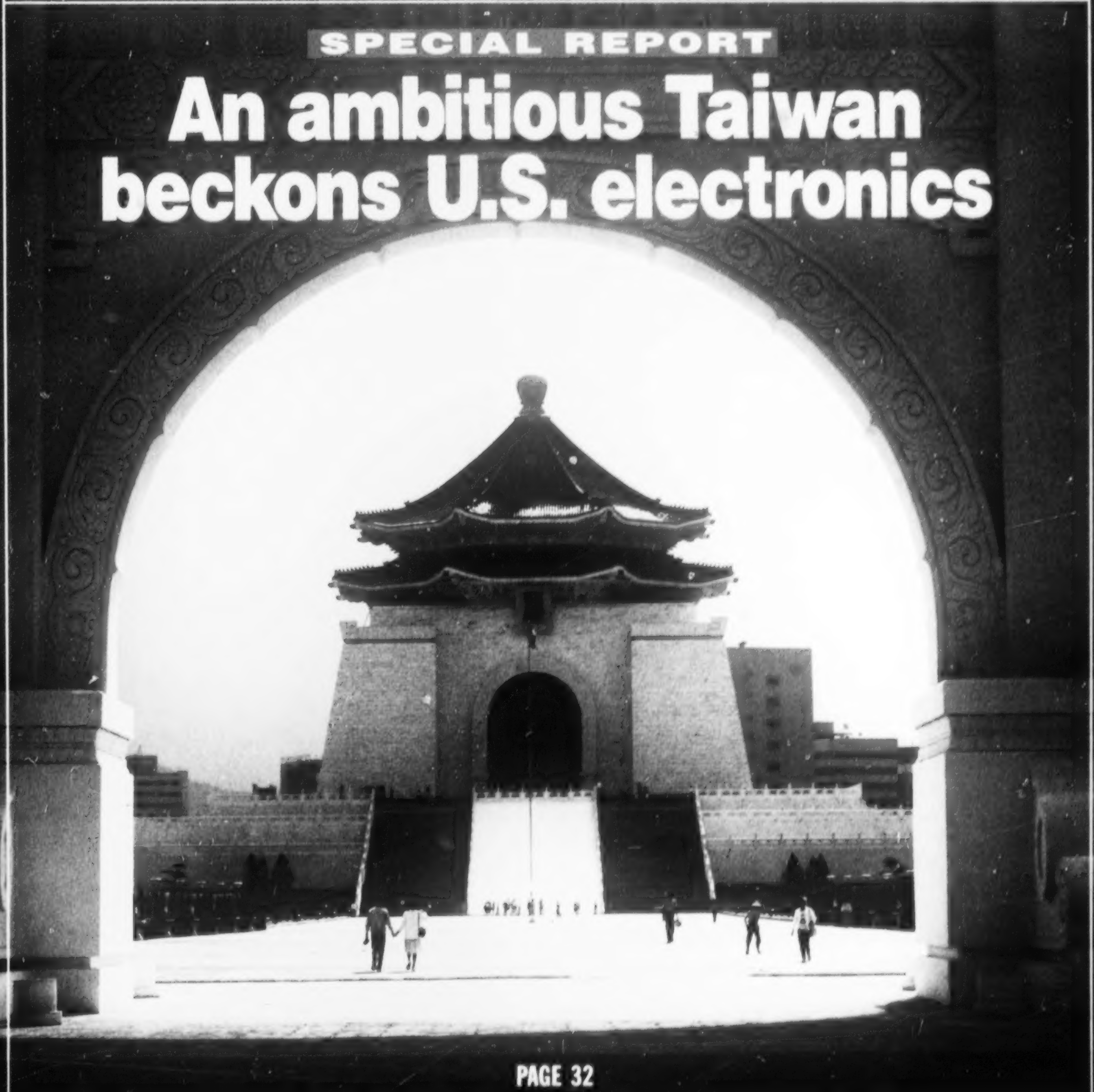
How corporate incubators keep innovation in-house
PAGE 58

Can EDA vendors deliver on their big promises?

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE
DECEMBER 9, 1991



SPECIAL REPORT

An ambitious Taiwan beckons U.S. electronics

PAGE 32

Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

Manfred Gottschalk/West Light

PAGE 32 A gateway frames the Chiang Kai-Shek memorial in Taipei

COVER STORY

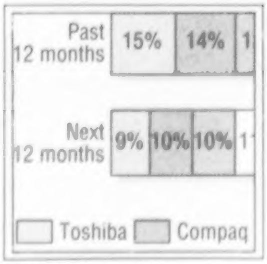
31 Letter from Taiwan

32 An ambitious Taiwan beckons U.S. electronics partners
As the world's seventh-largest producer of electronic products, Taiwan is no longer content to be just another clone maker. The nation has set its sights on the design and production of more higher-value products. The good news is that for the growing number of U.S. electronics companies seeking a leg up in the booming Pacific Rim marketplace, Taiwan may become a key foothold for them

UPFRONT

Business Trends

11 Drive makers in black hole; Chip vendors put 3-volt ball into OEMs' court; Sun, Compaq, and Toshiba face market share threats; Don't expect a recovery soon, say distributor execs; Yuletide disaster control at Mentor Graphics?



Shifting fortunes in workstation market

Companies to watch

21 Star Semiconductor Corp. gives DSP chips more power; NeoCAD Inc. makes software for designing FPGAs; Keyfile Corp. automates office tasks

Business Barometer

25 Semiconductors Microprocessors drive chip recovery

26 Leading Indicator Leading Indicator slumps in September

FEATURES

International

48 Does Korea Inc. need a new boss?
Korean industry is starting to wonder if less government support—and intervention—wouldn't be a lot better

Management

58 Don't just lay an egg—hatch a profit center
Many companies such as Xerox and AT&T hope that corporate "incubators" will keep important new technologies—and restless innovators—close to home

Markets

66 EDA vendors learn a painfull lesson
Sagging growth rates force suppliers of electronic design automation software to be more serious about satisfying their customers' needs

Markets

75 Can plain ol' copper bring fiber performance to the desktop?
A copper-based FDDI standard would reduce the costs and create the opportunity to retrofit workstations on existing networks to handle 100 Mbps

DEPARTMENTS

Inside Business

7 Opportunity and crisis along the Pacific Rim

My View

87 Winners not whiners

Company Index

90 Companies covered in this issue

Advertiser Index

91 Advertisers covered in this issue

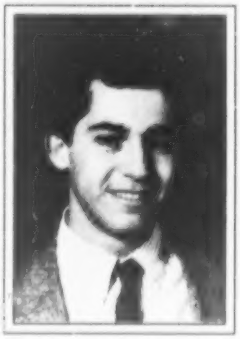
Viewpoint

92 Let Electronic Business be your guide and handbook

INSIDE BUSINESS

Opportunity and crisis along the Pacific Rim

PERSPECTIVE can be everything. A perfect example is the Chinese ideogram that can be read as either "crisis" or "opportunity." We've all read about the crisis of competition from Asian electronics companies; this issue of ELECTRONIC BUSINESS focuses on the opportunities for U.S. companies in forging partnerships along the Pacific Rim.



Senior editor
Peter Burrows

Many of the partnerships are taking root in Taiwan, where quick-paced technological development, fired by an intense entrepreneurial spirit, is reminiscent of another island nation—mid-20th-century Japan. In our cover story, senior editor Rick Whiting tells how Taiwanese companies, unwilling and economically unable to rely on sales of low-capacity chips or computer clones, are reaching out to U.S. companies for the design and marketing expertise needed to compete as vendors of high-end processors and systems.

The evolution of Korea's electronics industry, meanwhile, creates almost a reverse image of our own. Korea's remarkable growth began with strong government intervention. As the growth curve flattens, however, Korean executives are looking for more private initiative.

Closer to home, previously high-flying vendors of electronic design automation software are feeling the drag of a cyclical crisis familiar to other electronics sectors: Technical innovation yields quick growth and high profit margins for a few companies, which encourages capital investment and spawns a host of competitors. As the market matures, the gap between yesterday's innovation and today's business needs develops. Sales growth slacks off, margins shrink, financing dries up, and vendors vanish. EDA vendors are learning to differentiate themselves from the competition, says senior editor Peter Burrows in his market report, by the quality of their customer relationships.

The best thing, of course, is to create one's own opportunities. West Coast associate editor David Webb describes how AT&T and Xerox are nurturing innovation by forming and funding R&D subsidiaries. The goal is to keep promising technology from leaving the company, even if it is considered off the beaten path of its business strategy. But you don't have to be a Xerox or an AT&T to learn from these model programs: There are a number of incentives a midsize company can offer to keep its best and brightest on board.

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editors: David Webb
Assistant Editors: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Nancy Rutter (San Francisco), Paula Doe (Seattle), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), Xiong Xiaoge, John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett,
Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

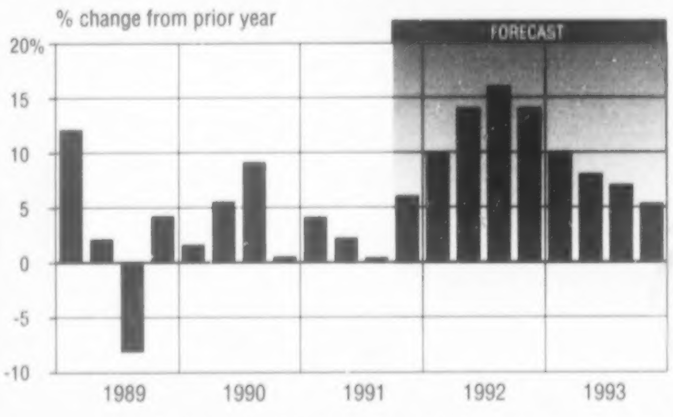
REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices.
Contact Andrea Marwitz, Cahners Reprint Service,
Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080,
Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1991 by Reed Publishing USA. Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $15.00 (USA, Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

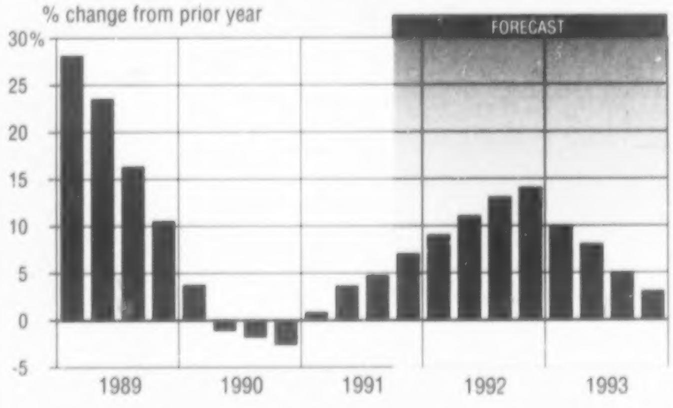
BPA ABP

Semiconductor orders growth is feeble in 1991...



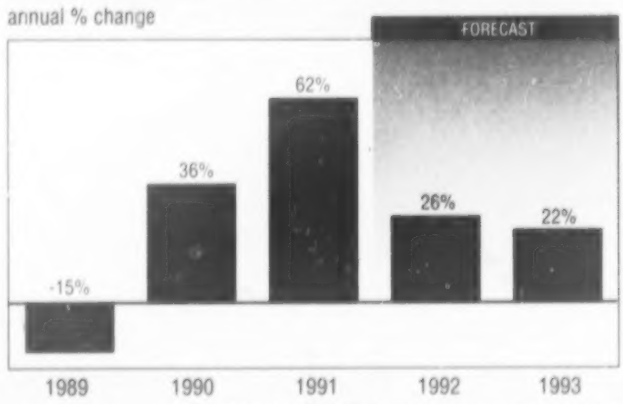
Source: Semiconductor Industry Association; forecasts: Cahners Economics

...as sales recover slightly from 1990 losses...



Source: Semiconductor Industry Association; forecasts: Cahners Economics

...thanks to strong growth in microprocessors



Source and forecast: Semiconductor Industry Association

Microprocessors drive chip recovery

SLUGGISH, WEAK, AND flat. That's how semiconductor execs have been describing their sales recently. The summer slowdown, coupled with a weak economy, pushed semiconductor sales to the U.S. market up only 4.8% in the third quarter of 1991 compared with a year ago, significantly below Cahners' previous expectation of 9.5% growth. Semiconductor sales increased faster than orders this past summer, suggesting the industry is cutting into its backlogs. The slowdown in orders growth has persisted for nearly two years. New orders inched up a meager 0.4% in the third quarter of 1991. All that has left the industry skeptical about a recovery materializing any time soon.

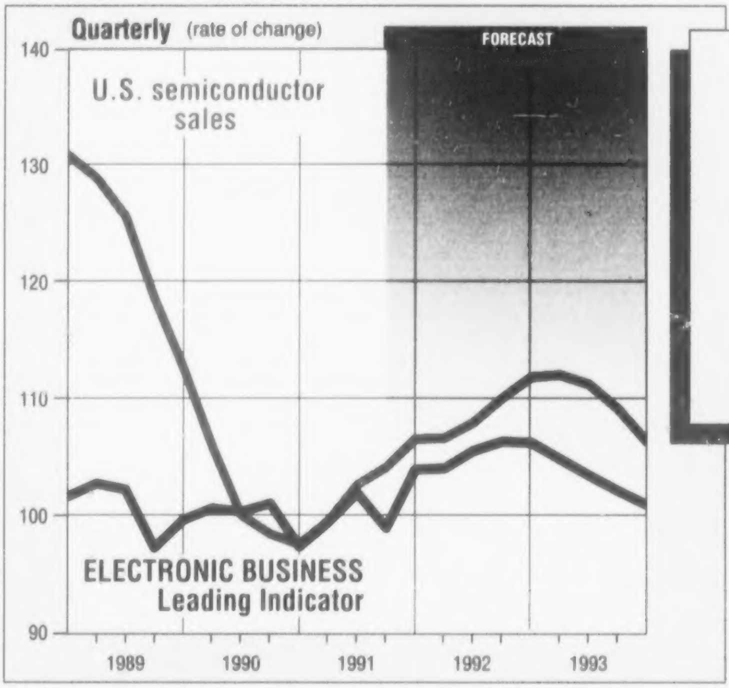
Fortunately, strong growth in microprocessors has boosted the market this year and will assist next year. Compared with other semiconductor markets such as memory, which rose only 6% for the 12 months ended in August 1991, microprocessor sales to the U.S. swelled 41.6%, to $1.31 billion, during that same 12-month period. Because the U.S. consumes 44% of all microprocessors, the U.S. outlook will mirror that of the worldwide market. The Semiconductor Industry Association predicts worldwide sales of microprocessors will skyrocket 62% this year and 26% in 1992. While most microprocessors can be found in computers, embedded controls, and autos, home appliance makers are eating up these chips now, too.

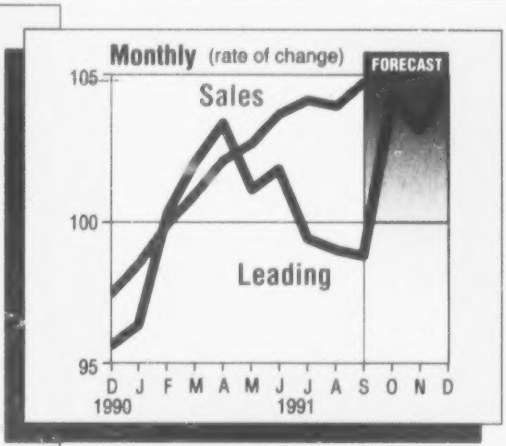
Watch for continued growth in semiconductor sales as falling interest rates eventually foster increased investment in capital equipment. With consumption of computers and office equipment increasing, demand for semiconductors will rise accordingly next year. Our forecasts call for semiconductor sales to the U.S. to climb a relatively slow 11.9% in 1992 to $17.2 billion.

—Julie Handelman

BUSINESS BAROMETER

ELECTRONIC BUSINESS Leading Indicator



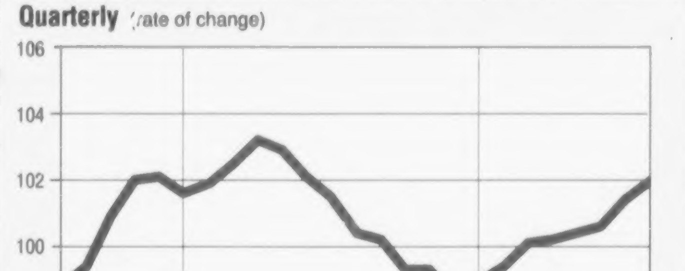


Leading Indicator slumps in September

THE ELECTRONIC BUSINESS Leading Indicator (EBLI) slumped for the third consecutive month in September at 98.7, a trend that may be indicative of slow industry growth ahead. The lack of a convincing EBLI recovery up to this point has pushed the next expected EBLI peak out to September 1992 at 106.9, three months later than our previous forecast.

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100.

Semi workers' weekly hours grows steadily



Source: Labor Dept.

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Sept.)	98.7	98.9	101.0	99.9
U.S. semiconductor bookings ($ millions, 3-month average, Sept.)	$1,209	$1,206	$1,179	$1,254
Weekly hours of semiconductor production workers (monthly average, Aug..)	40.7	40.2	39.4	40.4
Electronic components lead time index (1977 = 100, Oct.)	89.9	81.4	64.0	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, Sept.)	66.4	72.3	56.7	64.6
Change in electronic components inventories ($ millions, SA, Aug.)	-$90	$48	-$181	$33
Contracts and orders for plant and equipment ($ billions, SA, Aug.)	$34.1	$40.3	$35.6	$38.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

An ambitious Taiwan beckons U.S. electronics partners

By Rick Whiting

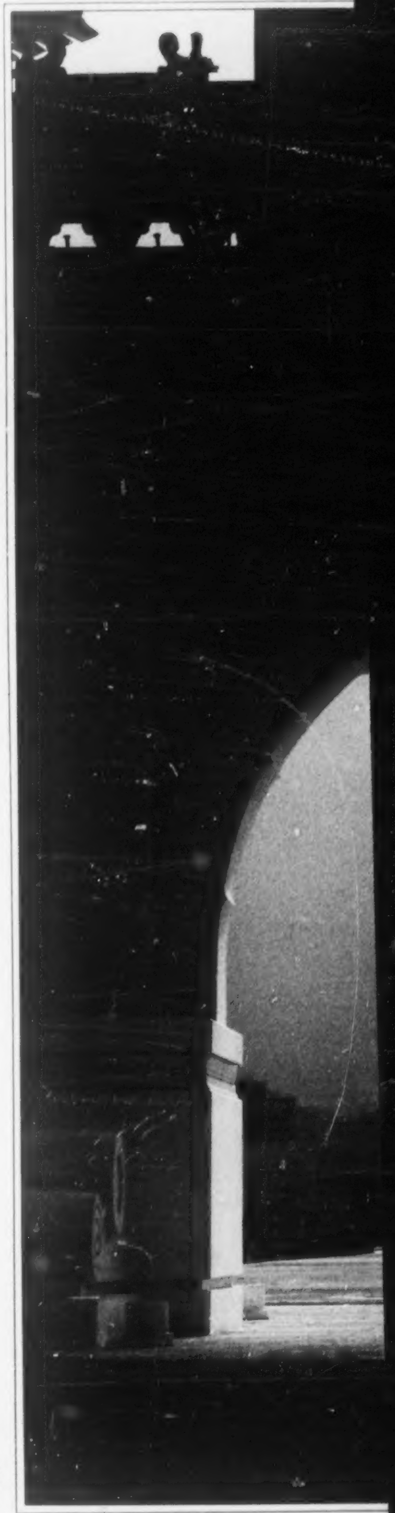
No longer content to be just another clonemaker, the nation has targeted high-value markets. That will call for some sophisticated industry allies

After years of producing PC clones, low-capacity DRAMs, and chips for electronic toys, Taiwan's electronics industry is being wrenched by change. Like Japan in the 1970s, Taiwan R.O.C. (Republic of China) has set its sights on the design and production of such higher-value products as application-specific ICs (ASICs), static RAMs, and liquid crystal displays (LCDs).

At the same time, Taiwanese producers of computers and peripherals are also moving upscale. Battered by plummeting profit margins and cutthroat markets, manufacturers have targeted palmtop and notebook computers, workstations, and X terminals.

All of that is good news for the growing number of U.S. electronics companies seeking a leg up in the booming Pacific Rim marketplace. The reason is that, in order to reach those goals, Taiwan needs corporate partners with expertise in electronic design automation (EDA), local area networks, wireless communications, system software, systems integration, multimedia, and other technologies. Selling those products, moreover, demands know-how in marketing, international distribution, and customer-support networks.

Taiwan is already the world's seventh largest producer of electronic products, behind the U.S., Japan, Germany, Britain, France, and Singapore. Overall, Taiwan's two-way trade worldwide skyrocketed from $3 billion in 1970 to $121 billion in 1990. The nation exported nearly $8 billion worth of electronic goods last year, including $5.9 billion in computer sys-



A gateway frames the Chiang Kai-Shek memorial in Taipei

Manfred Gottschalk/West Light

tems and peripherals and $1.2 billion in semiconductors. Also last year, Taiwan shipped computers and related peripherals valued at $2.32 billion to North America—mostly to U.S. OEMs that resell the products under their own labels. Semiconductor exports to the U.S. reached $378.1 million in 1990.

ALTHOUGH TAIWAN'S IC industry is well established, however, "we still have a long way to go to catch up with Japan, the U.S., and even Korea," says David C. Hsing, general director of the Electronics Research & Service Organization (ERSO), a government agency charged with upgrading Taiwan's semiconductor production capability. Taiwan's IC production exceeded $1.57 billion in 1990.

Company executives and government officials say that U.S. companies have what Taiwan needs. In return, the nation claims to offer:

- Advanced semiconductor production facilities that U.S. chip makers can use to gain time-to-market advantages and avoid building costly fabs on their own;
- A highly skilled and educated work force familiar with the business style of U.S. companies and the quality culture of Japanese vendors;
- Low-cost capital and government incentives to develop and produce high-end electronics products in partnership with Taiwanese companies;
- A base from which to penetrate the Pacific Rim, economically the fastest-growing region in the world.

While the Texas Instruments Inc.-Acer Inc. alliance to produce DRAMs has garnered a lot of attention, a long list of smaller U.S. companies, such as Seeq Technology Inc. and Chips & Technologies Inc., have established partnerships in Taiwan. As more U.S. semiconductor companies opt to go fabless, observers predict the number of U.S. companies seeking alliances in Taiwan will grow.

For U.S. vendors looking for new sales turf, the evolution within the Taiwanese electronics industry is creating potential markets for everything from digital-signal processors and connectors to EDA software and test equipment. In 1990, for example, local manufacturers could supply only 13% of the $2.6 billion in semiconductors needed by Taiwanese PC companies and other manufacturers; the rest were imported, with 34.6% of those imports coming from the U.S.

Western Digital Corp. counts some 30 Taiwanese notebook PC makers as customers for its core logic chipsets, video and storage controllers, and disk drives. Teradyne Inc. has sold analog, digital, and memory test equipment to several Taiwanese semiconductor manufacturers and in August sold a memory test system valued at more than $1 million to ERSO. Synopsis Inc., a vendor of electronic design software that set up shop in Taipei a year ago, now lists PC maker Acer, chip manufacturer United Microelectronics Corp., and ERSO as customers.

TAIWAN MAY ALSO APPEAL to U.S. electronics companies because of its business climate and culture. Taiwanese companies "are a lot more like U.S. companies than those in other [Pacific Rim] countries," says Ken Lindsay, Asia/Pacific business manager for Valid Logic Systems subsidiary IMS, which counts most major Taiwanese semiconductor manufacturers among users of its IC design debugging software. Given the influence of the large number of U.S.-owned subsidiaries in Taiwan, executives tend to follow strategies and management styles similar to those of their U.S. counterparts. Reinforcing the similarities is the fact that there are some 30,000 Taiwanese engineers now working for electronics companies in California and many more in Taiwan that once worked in the U.S.

Unlike Japan and Korea, whose electronics industries are dominated by a handful of huge conglomerates, Taiwan provides a more hospitable business environment for U.S. vendors because the country's electronics industry is made up largely of small companies eager for—and more in need of—strategic alliances with Western companies. Tatung Co., Taiwan's largest electronics corporation, reported sales of just more than $1 billion in 1990, and Taiwan's top 10 electronics companies had combined sales that year of $3.4 billion. That barely exceeds the sales of Japan's Nintendo, ranked 16 on ELECTRONIC BUSINESS's list of Japan's top 50 companies. Samsung Electronics, Korea's largest electronics company, had 1990 sales of $6.37 billion.

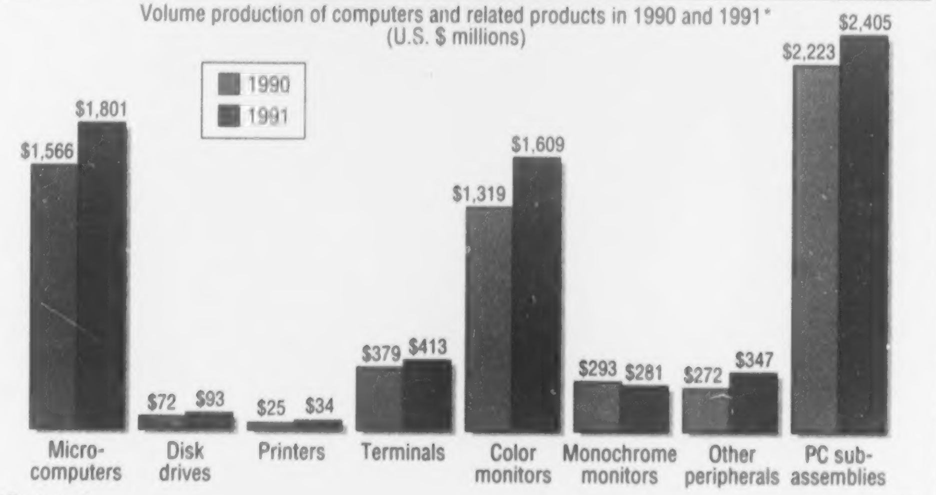
Critical to achieving success within the Taiwanese electronics market is viewing it as a place to establish strategic relationships. Taiwanese companies are looking for partners, not just vendors.

"You've got to come in with a technology they can turn to their own use," says Harry Sello, a Menlo Park, Calif.-based technology licensing consultant. "Use the technology to penetrate the market. There are opportunities for U.S. companies in Taiwan as long as they are willing to team up and meet the Taiwanese desire to become independent and a force within the worldwide IC industry."

Many companies make use of local distributors to help generate sales leads. But successful companies do not rely solely on third parties for customer service, preferring to work directly with customers—either through frequent visits or a permanent support staff. Both Western Digital and LSI Logic Corp. maintain

What Taiwan makes

Volume production of computers and related products in 1990 and 1991*
(U.S. $ millions)



*Projected

Source: MIC

design centers in Taipei where they work with customers to incorporate their products into Taiwan-built PCs and computer boards.

"It takes a while to build up trust and develop a working relationship," says John Lee, director of consumer products at The DSP Group Inc. in San Jose, which markets digital-signal processor chipsets to Taiwanese manufacturers of digital answering machines and cordless phones.

JAPANESE VENDORS HAVE made gains against U.S. companies in some Taiwanese markets by offering customers extensive training, on-site support, and rapid response time, says Howard Young, vice president and co-founder of California Quartz Inc., a San Jose marketer of quartzware products used in chip fabrication. Japanese competitors have already overtaken U.S. companies in selling photolithography equipment in Taiwan, says Paul Callendar, director of Asian sales for etching equipment vendor Lam Research Corp. in Fremont, Calif. Lam, Callendar says, is putting more emphasis on direct sales in Taiwan.

Taiwan, however, is not a place for U.S. companies seeking cheap labor for manufacturing or assembly. The country's unemployment rate hovers around 2%, and there is a shortage of unskilled labor. Within the manufacturing sector, the average hourly wage has reached \$3.70—low compared with \$10.66 in the U.S., but higher than Malaysia, Thailand, and mainland China (to which even several Taiwanese companies have recently moved their labor-intensive manufacturing operations).

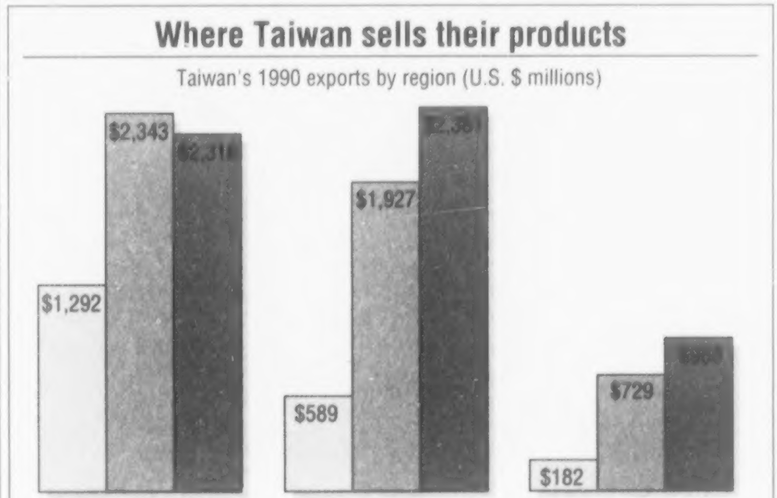
THE RAPID GROWTH OF Taiwan's electronics industry has also boosted demand for engineering talent. Job-hopping by the best and brightest resembles that of Silicon Valley in its early days. Hiring experienced engineers will not come cheaply for U.S. companies establishing local subsidiaries or service/support centers.

U.S. companies seeking customers and partners in Taiwan face other problems. Distribution and support are particularly difficult given the plethora of small, emerging companies in the country, says Mike Burger, National Semiconductor Corp.'s Asia sales director. Also, buying patterns among the small companies quickly rise and fall with the economy, making the electronics market very cyclical.

Doing business in Taiwan has other idiosyncrasies. Taiwanese businessmen are "fierce negotiators" and will take their time when it comes to striking a deal, says one U.S. chip company executive; and while having the lowest price was all that was once needed to win a sale in Taiwan, California Quartz's Young says quality is becoming a factor in Taiwanese corporate buying decisions.

Other U.S. executives with experience in Taiwan are critical of the country's business culture, saying Taiwanese business people often take a very short-term outlook in their planning and focus on making a quick profit "These guys would just as soon be selling shoes if there were as much money in it," says one observer who asks not to be named.

As proof, several observers point to the low level of investment Taiwanese electronics companies make in R&D. Even the cream of Taiwan's electronics industry—the chip and computer companies in the sprawling



Source: MIC/III

Acer CEO Stan Shih: "Many, many opportunities" for U.S. companies

Hsinchu Science Industrial Park southwest of Taipei—spend less than 5% of sales on R&D, versus 9% average among U.S. electronics companies.

Protection of intellectual property remains an issue for U.S. companies doing business in Taiwan. Last year the Taiwanese government instituted a number of copyright and patent protection laws for software and semiconductors in an effort to improve the business climate for foreign companies.

"Yes, they have put laws on the books, but to my mind, those laws are not being sufficiently enforced," says consultant Sello. "I would suggest extreme caution in how your technology is being used." He and other Taiwan watchers point to software and ASIC designs as being particularly sensitive areas.

TAIWAN REMAINS VERY protective about its own technology, however. Earlier this year, an agreement between AT&T and the Taiwanese government's Industrial Technology Research Institute (ITRI) to cross-license semiconductor, optical, computer, and superconductivity technology was put on hold. An AT&T spokesperson says that Taiwan's laws need modification to give ITRI the authority to sign the agreement, but a source says the deal was sidelined by Taiwanese government officials who considered their technology to be proprietary.

Indications are that efforts by Taiwan companies to link up with foreign companies will increase. In early 1991, Taiwan's China External Trade Development Council began the trade opportunity project in which the agency will play matchmaker between Taiwanese companies and foreign companies seeking joint ventures or technology transfers. The major effort is in electronics and information systems, according to project manager Fred M. C. Chang. He hopes to establish some 30 to 40 alliances each year.

Despite the crash of Taiwan's stock market

Taiwan provides springboard for Pacific Rim expansion

IN ADDITION to being a place for U.S. electronics companies to do business, Taiwan can also serve as a jumping-off site for vendors looking to expand into mainland China and other Pacific Rim countries.

Working in Taiwan's favor is its geographic location, roughly in the midst of the Asia/Pacific region. Japan and South Korea are to the north, Singapore to the south, and Hong Kong and mainland China a short plane ride away. Other developing nations, such as Malaysia, Thailand, and the Philippines, lie to the south.

"If you're an American company and you want to be in the Pacific Rim and want to push into China, I would be in Taiwan," says Dan Heyler, a Taiwan-based analyst for Dataquest Inc.

With Hong Kong, the region's traditional crossroads, slated to revert to Chinese control in 1997, some Taiwanese corporate executives and government officials quietly mention the island nation as an alternative. They also acknowledge, however, that they have seen little evidence of movement of capital or corporations from Hong Kong to Taiwan. Others suggest that Singapore will inherit Hong Kong's role in the region, given its base of financial service companies.

But Taiwanese companies have been establishing themselves throughout Asia, including mainland China. Economists estimate that Taiwan-China trade alone will reach $5 billion this year. In September, Taiwan even began discussing economic ties with Vietnam, and Taiwanese telecommunications vendor Taicom is close to establishing a joint venture with the communist country's Telecommunication Bureau.

Partnerships with such adventuresome Taiwanese companies can boost the fortunes of U.S. companies looking to expand across the region. "Taiwan can be a good partner in marketing and selling in this area," says John Hsuan, president of United Microelectronics Corp. ☐

Taiwan's computer industry in perspective

	1986	1988	1990
Total production (in U.S. $ millions)	$2,134	$5,324	$6,149
Information technology (as a % of Taiwan's GNP)	2.7%	4.2%	3.8%
Computer products exports (in U.S. $ millions)	$2,063	$5,152	$5,873
% of worldwide information technology market	1.5%	3.1%	3.0%

Source: ERSO

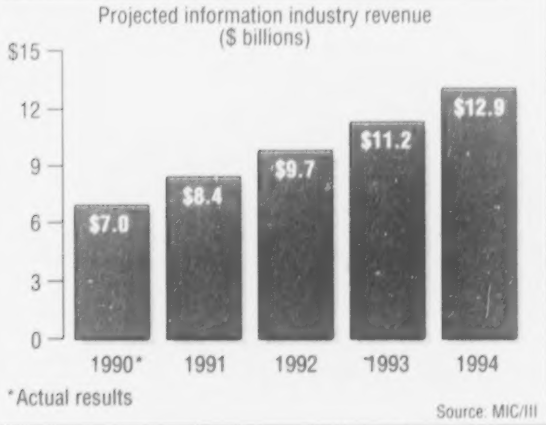
last year, Taiwan remains a cash-rich country with some $75 billion in foreign exchange reserves, second in the world only to Japan. Low-cost capital is still plentiful from both private and government sources, although banks appear more cautious in their lending than they were during the late 1980s.

Under the Statute for Upgrading Industries tax law, which took effect last Jan. 1, companies can receive tax credits of 5% to 20% for investments in automated production equipment or technology and for R&D outlays. The government is also willing to sponsor up to 50% of development costs for advanced products or provide loans for R&D. Those incentives are available for Taiwan-based subsidiaries of foreign companies as well as for native companies.

ERSO is in the midst of a five-year, $289 million program to expand Taiwan's submicron semiconductor manufacturing capability, and the project is providing U.S. companies with opportunities. Because ERSO serves as a training ground for many semiconductor engineers in Taiwan, companies that sell production equipment to the agency are, in effect, developing a future customer base. In addition to selling ERSO test equipment with a $1 million price tag, Teradyne is jointly developing advanced test technology with the government agency. Applied Materials Inc. is doing the same in vapor deposition.

Also working in favor of U.S. companies is Taiwan's desire to lessen its dependence on Japan for semiconductors, components, and other electronics products. A growing trade deficit with Japan, combined with a historical antipathy for the Japanese (Japan occupied Taiwan for 50 years until the end of World War II), is fueling the move toward partnering with, and buying from, companies from outside Asia. "If they could find a good source of supply from Europe or the U.S., most Taiwanese companies would prefer it," Chang acknowledges.

Taiwan's growing information products industry



Source: MIC/III

IN THE COMPUTER ARENA, less government intervention rather than more may provide the opportunities. Taiwan's government has, in recent years, been aiding efforts by Taiwanese companies to develop notebook PCs, workstations, X terminals and other products. Using funds chipped in by the companies, the government Computer and Communications Research Laboratory has developed base technologies that the participating companies use to build products. There is, however, a growing sense among both vendors and government officials that that approach only encourages companies to build clone products with little or no added value.

Industry leaders such as Acer chief executive Stan Shih advocate what he calls "vertical consortia," in which companies ally themselves with suppliers of graphics boards, networking technology, and software to provide customers with more feature-rich systems. "There are many, many opportunities to link together," says Shih. ☐

The China External Trade Development Council maintains a New York office. Phone (212) 532-7055; fax (212) 213-4189.

U.S. chip makers trade know-how for capacity

In return for their state-of-the-art design, U.S. companies get access to well-heeled foundries that will produce half-micron semiconductors next year

By Rick Whiting

Taiwan's semiconductor industry is trying to move upscale, and it needs help from U.S. companies to do it.

Because Taiwan's PC clone and consumer electronics manufacturers have traditionally been the driving force behind the country's semiconductor industry, chip makers have concentrated on manufacturing such commodity products as low-capacity DRAMs and chips for electronic toys. Now, facing competition from other Asian countries, Taiwan's chip industry must change. "Taiwan cannot compete with Japanese or Korean companies in volume commodity businesses," says John Hsuan, president of semiconductor maker United Microelectronics Corp. (UMC).

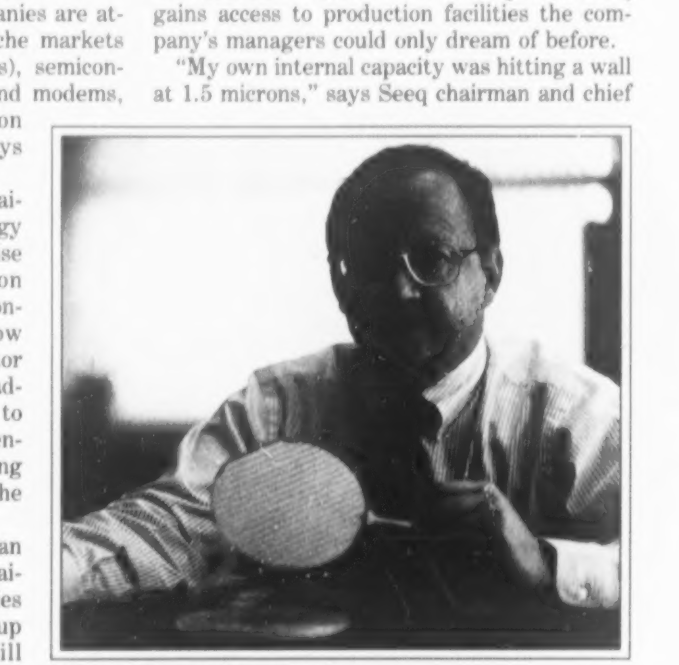
Taiwanese semiconductor companies are attempting to expand into such niche markets as application-specific ICs (ASICs), semiconductors for telecommunications and modems, static RAMs, image compression chips, and liquid crystal displays (LCDs).

In order to make that move, Taiwanese engineers need technology and customer application expertise from U.S. companies, says Don Brooks, one-time Fairchild Semiconductor chief executive and now president of Taiwan Semiconductor Manufacturing Co. "There's no leadership in Taiwan for these guys to learn from," he says. "Taiwanese engineers may be adept at executing new designs. Where they miss the boat is knowing what to design."

Altogether, there are more than 60 semiconductor companies in Taiwan, though only eight companies operate fabrication plants (start-up Macronix International Co. will make nine) with the rest limited to design work. Taiwan's semiconductor industry, largely concentrated in the Hsinchu Science Industrial Park southwest of Taipei, enjoyed a 27% compounded annual growth rate between 1986 and 1990. Production reached $1.57 billion last year, including design, manufacturing and packaging operations, and exports reached $1.19 billion, of which 31.8% went to the U.S., 18% to Europe, and 11.6% to Japan.

San Jose-based Seeq Technology Inc. is trading its flash memory designs for the foundry capacity of Hualon Microelectronics Corp. (HMC). By moving its volume production of electrically erasable programmable read-only memory (EEPROM) chips and Flash EEPROMS to HMC's Hsinchu plant, Seeq gains access to production facilities the company's managers could only dream of before.

"My own internal capacity was hitting a wall at 1.5 microns," says Seeq chairman and chief



TSMC president Don Brooks: "There's no leadership in Taiwan for these guys to learn from"

Semiconductor manufacturing in Taiwan

	1987	1988	1989	1990
Number of manufacturers	3	6	6	8
Revenue (U.S. $ millions)	$119	$154	$284	$337
Growth rate	25%	29%	84%	19%
Process capability (in microns)	2.0	1.5	1.2	1.0
R&D spending as % of sales	NA	NA	10.0%	11.1%
Taiwan semiconductor consumption (in U.S. $ billions)	1.5	1.8	2.2	2.5

*NA = not available

Source: ERSO

executive J. Daniel McCranie. Building the 1 micron fab that Seeq needed would have cost $300 million—and Seeq's annual sales are only in the range of $350 million a year.

HMC began producing Seeq's 1.2 micron EEPROMs in October, a little more than one year after the two companies formed their partnership. The companies are now developing 1 micron EEPROMs and plan to move to 0.8 microns in the future. Plans also call for HMC to manufacture analog parts for Seeq's Ethernet product line and the companies will jointly develop Extended Industry Standard Architecture-based Ethernet data link controllers and 10BaseT analog chips.

The Seeq-HMC partnership goes beyond contract manufacturing in that HMC bought a 10% stake in Seeq to secure the long-term relationship. HMC also has non-exclusive rights to sell products based on Seeq designs, although McCranie says HMC cannot use Seeq technology or processes without permission.

THE NEWEST PLANT in Hsinchu is the result of a $350 million joint venture between Texas Instruments Inc. and Taiwan PC manufacturer Acer Inc. The companies will split the plant's projected output of more than one million DRAMs per month, with Acer using its share in its own computers while TI sells its share on the open market. Acer gains a steady supply of DRAMs free of price fluctuations while TI gains fabrication capacity with minimal risk or capital investment.

Even though the facility was formally dedicated on Sept. 26 in a ceremony presided over by TI chairman Jerry Junkins and Acer Inc. chief executive Stan Shih, the plant actually began pilot production of 4-megabit DRAMs in July. Volume manufacturing is slated to begin early next year and future plans call for producing both ASICs and 16-Mbit DRAMs. The facility has 0.8 micron CMOS capability and will be upgraded to 0.5 microns by the end of 1992.

Acer and the China Development Corp. provided most of the plant's funding and together hold a 74% stake in the TI-Acer venture. TI is providing the advanced 4-Mbit and 16-Mbit DRAM technology. Acer also brings plant management experience to the party while TI is providing training for plant engineers.

AS A PURE FOUNDRY, TSMC devotes 100% of its capacity to building products for other companies. Brooks says that TSMC is currently manufacturing mixed analog-digital chips, digital logic, SRAMs, erasable programmable read-only memories (EPROMs) and other semiconductors for some 50 customers, both Taiwanese and foreign companies.

TSMC's major customers include NV Philips, which holds a 27% stake in the company, and Advanced Micro Devices Inc. Philips and AMD have both transferred process technology and designs to TSMC. The Hsinchu-based company is also working with Chips & Technologies Inc. on microprocessors and other projects that Brooks declines to discuss and has licensed gate array designs from VLSI Technology Inc., another customer.

UMC's partnerships with U.S. companies began in 1985 through a deal with TRW Inc. to manufacture echo cancellation chips for telecommunications applications, a partnership that gained UMC access to TRW's 1.25 micron technology. The two companies have since expanded their relationship to include manufacture of analog-digital converters. Hsuan is closed-mouth about UMC's other relationships.

UMC dedicates 20% of its Hsinchu foundry capacity to contract manufacture work and Hsuan says the demand for contract manufacturing is increasing. UMC is also converting part of its oldest fab for manufacturing thin-film transistor LCDs on a contract basis for U.S. companies. Hsuan acknowledges that jumping into LCDs, a technology largely dominated by Japan, is risky, but trade friction between the U.S. and Japan over LCD screens could provide the company with a major opportunity. UMC hopes to begin pilot LCD production in the fourth quarter of 1992.

Not all U.S.-Taiwanese semiconductor partnerships have been happy marriages. Intel Corp. had deals with both TSMC and UMC that went sour. TSMC was to have manufactured 256-Kbit and 1-Mbit DRAMs for Intel, but Intel pulled out earlier this year—presumably because DRAM prices were skidding. Brooks will say only that the partnership was ended by mutual decision.

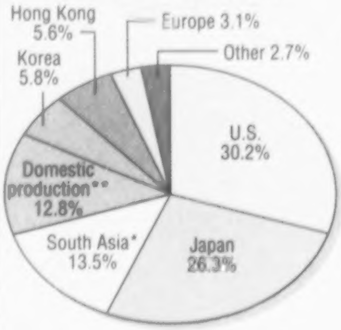
UMC and Intel were to have jointly produced 4-Mbit and 8-Mbit flash EEPROMs under a contract signed in November 1990. But Intel, Hsuan says, wants fabrication equipment to be dedicated to Intel products while UMC wants to use the excess capacity when Intel products are not rolling off the line. Hsuan will only describe the partnership as "on hold."

Macronix is cited by some as *the* up-and-coming semiconductor company in Taiwan. Founded by Taiwanese engineers who worked in the U.S., Macronix, in fact, considers itself a U.S. company and maintains its headquarters in San Jose. A recent Dataquest report cites Macronix as an example of a Taiwanese company "that has distinguished itself by adopting a more global view" and making plans for long-term profitability. Macronix has raised some $80 million in venture funding and is completing the first phase of what may be the most advanced fabrication facility in Hsinchu. ☐

Where Taiwan gets its semiconductors

Sources of semiconductors consumed in Taiwan

1990 total = U.S. $2.56 billion



*Singapore and Malaysia
**Includes semiconductor packaging

Source: ERSO

Major players in Taiwan's semiconductor industry

Company	Process technology (microns)	Monthly production	Date of operation	1989 revenue ($ millions)	1990 revenue ($ millions)
United Microelectronics	1.5-5.0 CMOS 1.0 CMOS	4-inch wafers 40,000 6-inch wafers 15,000	1/82	$117.4	$148.7
Taiwan Semiconductor Manufacturing	1.5 CMOS 1.0 CMOS	6-inch wafers 12,000 6-inch wafers 10,000	7/87	72.0	84.4
Winbond Electronics	1.0-5.0 CMOS 1.0 BiCMOS	5-inch wafers 20,000	10/88	37.9	48.3
Hualon Microelectronics	1.0 CMOS 1.2 NMOS	5-inch wafers 25,000	7/88	45.5	44.6
Advanced Device Technology	2.5-5.0 CMOS	4-inch wafers 15,000	1/86	7.6	5.6
Advanced Microelectronics Products	2.0-5.0 CMOS	4-inch wafers 10,000	10/88	3.8	5.6
Unique Technology Integrated Circuit	2.0 CMOS 3.0 BiPolar	5-inch wafers NA	9/90	NA	NA
Holtek Semiconductor	2.0 CMOS	5-inch wafers NA	12/90	NA	NA

*NA = not available

Source: ERSO

EDA vendors learn a painful lesson

Faulty software and poor service slowed the growth of the $3 billion electronic design automation market this year

By Peter Burrows

With growth rates sagging for the first time in the industry's 10-year history, the technology-minded vendors of electronic design automation (EDA) software are getting more serious about satisfying their customers' full range of needs. To overcome a tough economy, product maturity in many key markets, and a more skeptical customer base, vendors are developing a broader vision of their business to make sure their products deliver on their well-hyped potential.

"It used to be that the vendors could sell any tool that was a little better than its predecessor, and they didn't have to be very attentive to particular customers' needs," contends analyst Shmuel Halevi of the Technology Research Group in Boston. "But now they can't succeed by just building a better mousetrap."

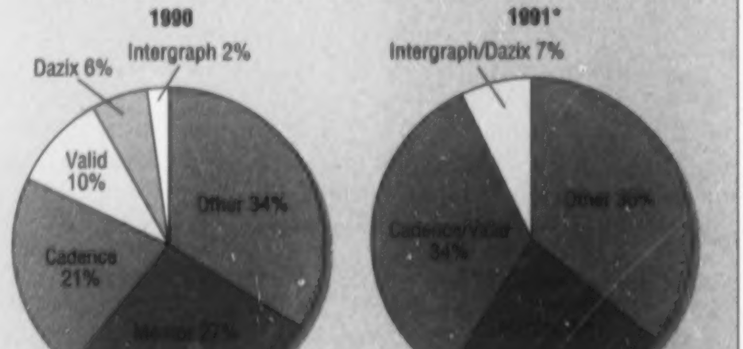
The new differentiators are old-fashioned concepts such as higher quality, service, support, and on-time delivery. "We've had too much emphasis on algorithms and fundamental core technologies," Cadence Design Systems Inc. president and CEO Joe Costello said in his keynote speech at the Design Automation Conference in June. Calling for a more "balanced" approach by vendors, he cited the need for more support, better documentation and training, and more vendor cooperation, among other changes. "Customers are looking for more complete solutions than ever before. They don't want just little bits and pieces."

The market numbers reflect the customer's dissatisfaction. After years of double-digit growth in the 1980s, the worldwide EDA market grew just 7% to $3.4 billion in 1991, according to the market research firm Dataquest Inc. in San Jose. Although forecasters expect a return to double-digit growth in 1992 due to improving economic conditions and market acceptance of a new generation of products, the temporary lull has put the squeeze on EDA vendors large and small. Costello estimates that net income of EDA vendors has been cut in half since the mid-1980s, down to 2% or 3% after tax for the industry as a whole. "That's more like a grocery industry than high technology," he said. High-flying Cadence's net profit fell to 7.8% of its $171 million in revenue for the first nine months of 1991, from 16.5% last year.

An industry consolidation has been the most striking result of shrinking growth and profits. Acquisitions have occurred at the rate of one a month for the last four years, says Dataquest analyst Ron Collette, including Huntsville, Ala.-based Intergraph Corp.'s purchase of Daisy Cadnetix Inc. in Sunnyvale, Calif. last year and San Jose-based Cadence's merger with Valid Logic Systems Inc., also of San Jose, last October. If the Cadence/Valid merger is completed this month as expected, the new Cadence will emerge as the market leader in EDA software sales with roughly 34% market share, bumping it ahead of long-time leader Mentor Graphics

Cadence catches Mentor amid EDA consolidation

Market share of U.S. vendors worldwide, software and services only



*Estimated

Source: International Data Corp.

EDA vendors overemphasized technological innovation at the expense of better customer service and support, admits Cadence CEO Joe Costello

Liane Enkelis

Corp. of Beaverton, Ore., according to Gisela Wilson with International Data Corp. in Framingham, Mass.

ANALYSTS EXPECT the consolidation trend to continue. "Companies that are set up for double-digit sales growth get scared" when growth slows, says TRG's Halevi. "The weaker players look for a way to leave the business profitably, and the stronger players look for acquisitions to gain market share."

Companies intent on surviving also are cutting costs and otherwise restructuring to adapt to the new realities—a sure sign that the EDA industry is approaching adolescence. Mentor Graphics, which lost $62.3 million in the past three fiscal quarters on $293 million in revenue, recently laid off 15% of its staff and scrapped product divisions for computer-aided software engineering and mechanical design to concentrate on its core EDA business. Cadence ordered an unscheduled shut-down in July. Prior to its acquisition by Cadence, Valid—like many old-guard EDA vendors—cut administrative costs and scrapped its low-margin hardware-reselling business. "Anyone can run a company whose revenues are growing at 20% to 30% a year, but that no longer describes the EDA business," says George Klaus, formerly Valid's president and the chief operating officer of Cadence. Upon taking the helm last autumn, Klaus began to restructure the company for less than 10% annual growth.

Nevertheless, managers at Valid, the industry's third-largest player, cited a scarcity of capital as the reason they merged their company's name out of existence. Although Valid recently appeared to overcome years of financial woes—four straight profitable quarters and a spate of multimillion dollar contracts this year—founder Doug Hajjar says, "It was hard to see how we could afford to keep up the pace of R&D investment five years from now." Hajjar will stay on at Cadence as vice chairman.

The long-term answer to improving margins is not cost-cutting, but increasing revenue by finding new competitive advantages that will command higher prices from appreciative customers. With that in mind, market leaders such as Cadence, Mentor, Intergraph's Dazix subsidiary, and Synopsis Corp. in Mountain View, Calif., have announced consulting divisions in the past year designed to make their design management expertise available to customers.

MOST OF THE CREDIT for the vendors' transformation goes to tougher customers, most of which are fed up with the bug-ridden software, serious delays, and the lackadaisical service policies of the past. "Computer-aided engineering is on the critical path of almost everything we do, but we've been living with half-baked tools for too long," says Jean Pierre Braun, who recently left his job as CAE director with Chips & Technologies Inc. in San Jose to join EDA start-up Sunrise Test Systems in Sunnyvale, Calif. "Today, the tools out there are similar enough so that you can put pressure on the vendor to go the extra mile." C&T insists that EDA salesmen leave actual software behind for C&T engineers to test in the comfort of their own facility instead of being forced to evaluate the system at vendor labs, an unheard of accommodation a few years ago.

The root of that new rebelliousness among customers is simple, explains Bruce Jenkins, an analyst with Daratech Inc. in Cambridge, Mass.: "The mystique has fallen away from EDA." Having witnessed the rise of highly-functional but inexpensive design tools for the PC platform, and the meteoric improvement in the price/performance of commercial PCs and workstations, customers that were dazzled by the $100,000-plus turnkey systems of the early 1980s now see EDA as just another capital-goods purchase where solid service and support are required. "Customers have come to realize that EDA vendors don't have any magic wands," says Jenkins.

Perceiving less value from the vendors' current product lines, customers are less apt to pay top dollar for traditional tools, making the new services a crucial revenue source for the future. Mentor recently set up a 440-person "Customer Success" organization that combines support, training, management consulting, and other services. Customers praise the unit, which has helped Mentor regain much-needed credibility with customers burned by the 12-month-plus delay in the shipment of Mentor's latest version of its software, the Release 8.0 design environment. Ultimately, the unit could contribute 25% or more of total Mentor revenues, predicts systems division president Gerard Langeler.

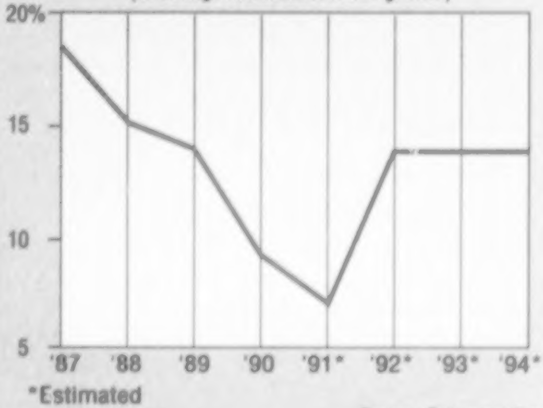
Mentor's relationship with General Electric Aerospace is at the cutting edge of that more comprehensive approach the industry is taking toward its major clients. With the customer-success organization taking a lead role, Mentor became the primary integrator for EDA systems at GEA in a five year, $25 million-plus deal that began in 1990. Not only did GEA mandate that Mentor integrate the software of seven competing EDA vendors into one companywide system, but as part of the package also requested that Mentor provide a range of other services—forge licensing agreements with other tool vendors, create training courses, schedule projects, write technical documentation, and customize its off-the-shelf products to work within GEA's existing design methodologies. In all, Mentor has 20 people devoted to the account, with ten on-site at any one time—more than at any other client.

> **"We knew our product wasn't tested, but we shipped anyway. The customers never said a word"**

After a slow start, GEA says it is pleased with the relationship, according to Dave Rollenhagen, manager of GEA's engineering support center in King of Prussia, Penn. The company is on track to reach its goal of improving engineering productivity by 25% by 1993, he says. "I don't think Mentor understood the role of an integrator at first, but it's turning out to be a win-win situation," says Rollenhagen. "We forced it into some new directions, but Mentor has come to realize that a lot of other large companies are going to want similar levels of service."

EDA to bounce back in 1992

(% change in annual revenue growth)



*Estimated

Source: Dataquest Inc.

Partnerships with the customers also help vendors improve their product direction, sometimes even yielding new technologies that can be commercialized. Mentor upgraded its model-library management system based on joint development with GEA. Cadence has expanded its menu of technology development partners with multiyear, multimillion dollar contracts to develop next-generation ASIC design tools with Fujitsu Microelectronics Inc. in San Jose and NEC Electronics Inc. in Mountain View, Calif.

To preserve their viability in a market increasingly dominated by vendors with a broader array of products, a host of small- to mid-size EDA vendors have developed networks of tight marketing agreements with each other or with larger competitors to give them access to customers with broad-line needs. That category includes niche players such as Analogy, Eesof, Logic Modelling Systems, Minc, Synopsis, and Zycad; in many cases, these companies do joint selling on a regular basis.

Service is another area where EDA vendors are trying to improve. While the benefit of pure technology is still the single most compelling reason to buy EDA, the maturing of the market has turned once-mundane factors such as service and support into critical differentiators. "We have been fair as far as service goes, but we need to be more proactive in finding ways to head off customer problems," concedes Lutz Henckels, president of Racal-Redac Inc., a Mahwah, N.J.-based unit of

Britain's Racal Electronics plc. As a start, Henckels recently created the position of "Mr. Corruption," a full-time telephone support specialist whose sole job is to help customers that gum up Racal's new-fangled object-oriented database retrace their steps and clean up their mistakes.

Other vendors are farther along in their efforts to improve service and support. Cadence "used to be absolutely pitiful," says one customer. "Very often we would get stuck in the mud because of some bug and it would just laugh at you, but it has made a lot of progress of late."

Other vendors have changed their ways as well. Viewlogic Systems Inc. in Marlboro, Mass. and Vantage Analysis Systems Inc. in Fremont assign at least one application engineer to each salesman to ensure that customers receive more sophisticated and responsive technical help. Due to the more customer-oriented approach, Viewlogic claims it is on track for 30% revenue growth this year while Vantage expects to grow almost 100%. "We didn't choose Viewlogic because of its tools; we chose it because of its service," says Braun, Chips & Technologies' former CAE manager. "It had applications engineers working in-house with us, and they were very willing to integrate our existing suite of tools into their environment. It has built up a lot of loyalty."

"We've been living with half-baked tools for too long," complains one EDA customer

Central to any notion of top-notch customer service is product quality, an area where EDA vendors have been grossly lacking. "The EDA user has been conditioned to think bugs are a cost of doing business, and the real kick in the teeth is that they get to pay a maintenance fee for the privilege of fixing them," says Wayne Gutschick, president of Colorado Springs-based Minc Inc., a vendor of design tools for programmable logic devices and field-programmable gate arrays. "We knew our first product wasn't well tested when we shipped it in 1988, but we closed our eyes and shipped anyway. You know something? The customers never said a word."

THOSE DAYS ARE COMING to an end, albeit slowly. With total quality management (TQM) in vogue, customers are less accepting of EDA vendors' transgressions. TQM crusader Motorola Inc. recently did a three-day audit of Mentor Graphics's software development. While Mentor didn't flunk the test, the company received the lowest passing grade possible, says a Mentor source.

Some EDA companies are now working to ensure better quality in their products. MINC, with only 40 employees, has invested about 50 man-years to develop automated software test tools that get 98%-plus coverage, says president Gutschick. Cadence devised a seven-dimension quality measuring criteria it calls the IQ system, and plans to pass all products through that comprehensive check before shipping, claims Costello. "Customers are starting to grade software quality just as they do hardware quality, and that is going to be a big competitive advantage for us," he predicts.

If the scores are good, that is. ☐

Will top-down design reinvigorate EDA?

IT'S BEEN 10 years since EDA pioneers such as Daisy Systems, Valid Logic Systems, and Mentor Graphics began selling electronic tools to do such work-a-day tasks as schematic capture and PCB layout. These tools, which essentially give customers an electronic alternative to pencil and paper, created an industry that has grown to more than $3 billion.

Now a new generation of products is available that changes the electronic design process. It's called top-down design and it promises to let designers describe a product's function—the new-fangled EDA tools determine the actual configuration of gates and circuits. Sales of top-down design tools based on high-level hardware-description languages (HDLs) such as the U.S. Department of Defense-backed VHDL or Cadence Design System Inc.'s Verilog, are expected to far outpace the rest of the EDA market. Revenue from HDL simulators for top-down design are expected to more than triple by 1995, to $245 million, according to the investment-banking firm Wessels, Arnold & Henderson in Minneapolis. The firm predicts that the market for logic-synthesis tools, which translate the high-level descriptions into actual gates and circuits, will grow sevenfold, to $285 million, between 1990 and 1995.

Tools that make concurrent engineering a reality also should foster increased growth. At the heart of that methodology, which speeds time-to-market by enabling engineers from different disciplines to work on a project simultaneously rather than in serial, are frameworks. These are software backplanes that let customers mix and match a range of tools—both in-house and from various vendors—in one tightly integrated design environment.

Until that new generation of products finds their way into the mainstream, however, EDA revenue growth will fall short of traditional levels. "The underlying reason is clear: the 'simple' problems have been solved, but no one knows how to solve the complex problems yet," says analyst with Shmuel Halevi with Technology Research Group in Boston. ☐

Can plain ol' copper bring fiber performance to the desktop?

If a 100-Mbps can be delivered over ordinary telephone lines, the FDDI market will soar to $1.5 billion

By Dwight B. Davis

Just three years ago, vendors were struggling to transplant the popular 10-megabit-per-second (Mbps) Ethernet local area networking standard from coaxial cable to unshielded twisted pair (UTP) telephone wiring to provide a more cost-effective link between desktop computers. At that time, the 100-Mbps fiber distributed data interface (FDDI) standard was far ahead of the network throughput needs and pocketbooks of most desktop users. The lack of a market stalled product sales for FDDI chip and system vendors such as Advanced Micro Devices, Ungermann-Bass, and Proteon.

Things are changing fast, though. Users' needs for broader bandwidth and higher throughput for image processing, graphics, and CAD/CAM applications has created a huge opportunity for datacom component and system vendors, if they can offer products that support high data rates over inexpensive copper wiring. Vendors are courting the desktop market with a fervor as they eye an installed base of 2 million workstations. A successful demonstration of fiber-like data transmission over copper would help to create a market estimated at $1.5 billion by 1994, according to analysts and vendors.

A copper-based FDDI standard would open up a huge market in two ways—not only are copper-based networks and components less expensive than their fiber counterparts, but the standard would create the opportunity to retrofit hundreds of thousands of workstations on existing networks to handle 100 Mbps. Currently, FDDI vendors struggle with a tiny market supplying components and fiber cabling for backbone links between local area networks and for other niche applications—the worldwide market for FDDI backbones in 1990 was less than 5,000 connections, according to the Gartner Group, a Stamford, Conn.-based research company. Only about 350 FDDI adapters for technical workstations will ship during 1991, estimates Brad Baldwin, an analyst with Gartner's San Jose office.

More than 50 vendors currently sell fiber optic-based interface products to link mainframes, workstations, and other devices to FDDI networks. Among the leading suppliers, according to the Gartner Group, are Sun Microsystems, Digital Equipment, Cisco Systems, Interphase, Fibronics International, and Network Systems.

Crescendo rushed to the non-fiber FDDI market before standards were in place because of user demand, according to company CEO Mario Mazzola

An American National Standards Institute (ANSI) working group charged with developing a standard for 100 Mbps over twisted pair wiring is scheduled to release its specifications by April 1992. The ANSI recommendations will encompass "voice-grade" UTP wiring and higher-quality "datagrade" UTP and shielded twisted pair (STP) wiring. Datagrade media have higher twist rates than voice grade and use higher quality material to encase the copper wiring; these differences improve transmission characteristics and immunity to outside electromagnetic noise. STP media have shielding that contains electromagnetic emissions and confers even better noise immunity.

IN ANTICIPATION OF the ANSI standards, vendors are developing—and in some cases already offering—FDDI adapter cards and central wiring hubs that will support the different types of copper media. The initial market for these products are workstations running applications such as computer-aided design and engineering, imaging, scientific processing, animation, and financial services. Vendors also expect high-end personal computers will need FDDI-type communications bandwidths to support applications such as multimedia.

Few users have yet connected FDDI links of any type to desktop devices, but a number of companies are investigating the technology. Boeing Computer Services of Seattle, for example, has several experimental versions of desktop FDDI products in its labs, using fiber optic, STP, and UTP adapters. "Before we adopt any new technology, we have to perform a business case analysis that examines end-user requirements, learning and support issues, and price considerations," explains Everett Rigsbee, senior network systems architect within BCS's Network Services and Support group.

Boeing has determined that several workstation applications could readily exploit 100-Mbps data rates. They include CAD/CAE and graphics-intensive "virtual reality" programs, Rigsbee says. Many Boeing buildings have STP wiring installed, while others have datagrade UTP plants. "The ability to add even a small amount of service improvement to the exiting media would represent a big plus to us," Rigsbee says.

Hoping to address such needs, seven vendors have banded together to test various methods for achieving FDDI over UTP. Calling itself the Unshielded Twisted Pair Development Forum (UDF), the group intends to demonstrate the feasibility of the technology soon, says Jayshree Ullal, director of product marketing at Ungermann-Bass Inc. of Santa Clara, Calif., a UDF member. This month, the UDF expects to present a unified proposal to the ANSI working group, recommending a single UTP solution from among the several techniques it has tested.

At least one UDF member isn't waiting for the completion of the forum's testing program, however. In October Crescendo Communications Inc. of Sunnyvale, Calif., announced a family of FDDI products designed to operate over STP, datagrade, and potentially voice-grade wiring. Slated to ship in January 1992, the start-up company's products will use

Emission control poses hurdle for copper

SEVERAL TECHNOLOGICAL hurdles must be jumped to support a 100-Mbps bandwidth on voice-grade unshielded twisted pair wiring. The biggest challenge is controlling electromagnetic interference (EMI). Light-based fiber-optic signals have no such emissions, and STP wiring has shielding that contains them.

The Federal Communications Commission limits EMI radiation for both office (class A) and home (class B) environments. Generally, the FCC restrictions apply to EMI frequencies above 30 megahertz (MHz). A key vendor objective is to build FDDI devices that can meet FCC class A requirements over reasonable distances of voice-grade copper wiring at a modest cost.

For vendors to achieve that goal, they must change the method by which data is encoded for transmission over the network. Standard FDDI encoding—developed for fiber-optic media—sends information at frequencies between 30 MHz to 80 MHz. In addition, repeating data patterns, such as those generated by a station's idle signal, can cause emission spikes.

To combat EMI, vendors propose a two-step solution. First, data to be transmitted is scrambled by an algorithm to eliminate any repeating data patterns and to smooth spikes. The second step is to encode the scrambled data in a way that reduces the transmission's frequency to below 30 MHz.

A group of seven companies calling itself the Unshielded Twisted Pair Development Forum (UDF) has been testing different line-encoding techniques to find one that can meet the FCC's EMI requirements and also be cost-effectively built into products. The UDF members are Apple Computer, AT&T Microelectronics, British Telecommunications, Crescendo Communications, Fibronics International, Hewlett-Packard, and Ungermann-Bass.

Only one of the encoding schemes, Carrierless Amplitude/Phase-32 (CAP-32), keeps the entire energy spectrum below 30 MHz. Considered "a powerhouse of a code," CAP-32 has been deployed by the telecommunications industry for years and is supported by AT&T Microelectronics. But CAP-32 is also the most complex of the schemes and potentially the most expensive to implement. UDF member Crescendo Communications already has developed a product line around a competing scheme called Multi-Level Transitional-3 (MLT-3), which, the company maintains, provides adequate FDDI performance over UTP at lower cost.

Another approach to reduce EMI emissions has potentially serious drawbacks. Vendors could reduce the power of the transmission signal and increase the sensitivity (and price) of the receiver, but this solution could limit the distance the signal could travel over UTP before it is overpowered by external noise or "crosstalk." Fiber-optic FDDI links are designed to operate over 100-meter distances, but to balance performance with low cost, future ANSI standards for FDDI over UTP may lower the distance requirement. Even if the distance should be cut in half, though, vendors and analysts agree that a UTP solution would be widely applicable: Up to 95% of employees' desks in offices are within 50 meters of the central wiring closet, according to recent studies. ☐

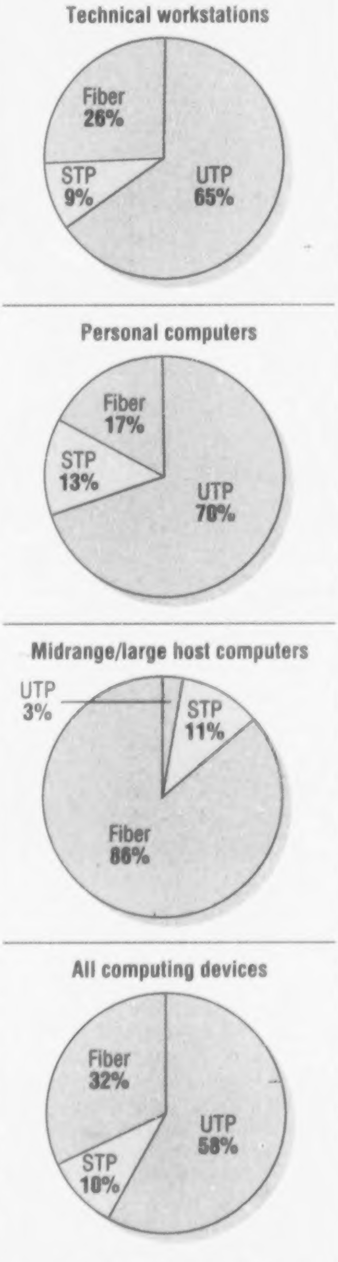
a proprietary data-encoding and scrambling scheme that the company has independently presented to the ANSI committee. Chief executive officer Mario Mazzola claims that Crescendo will offer existing customers a hardware upgrade to achieve ANSI compatibility if that becomes necessary, but he admits that the cost of such an upgrade can't be determined.

Crescendo rushed to the market because many users already are demanding less expensive components to achieve 100-Mbps links between desktop workstations, claims Mazzola. Fiber-optic FDDI adapter cards for workstations typically cost between $5,000 and $12,000, in many cases as expensive as the workstations themselves. One of Crescendo's first products will be a $1,495 UTP-based FDDI adapter card that is compatible with workstations using the Sun Microsystems Inc. S-Bus. Throw in the UTP concentrator module for $900—a workstation in a twisted pair FDDI network must connect to a concentrator or other device that functions as a hub—and the cost per station totals just under $2,500.

Pricing advantages such as these will inspire anywhere from 100,000 to 200,000 workstation owners to quickly move to UTP-based FDDI links, if the vendors' claims of functionality and cost-efficiency are proven, estimates Juan Figueroa, FDDI marketing manager at AT&T Microelectronics' MOS division in Allentown, Penn. By 1993 or 1994, he

Non-fiber media to dominate FDDI market

(% of networked systems using FDDI in 1995)



Technical workstations

Personal computers

Midrange/large host computers

All computing devices

Note: UTP= unshielded twisted pair
STP = shielded twisted pair

Source: Gartner Group

Don't count fiber out

WITH MUCH OF THE FDDI community focused on achieving 100-Mbps transmission over UTP wiring, it is possible to overlook progress being made to reduce the cost of fiber-based networks. Just as ANSI has a working group developing a proposal for a UTP standard, it also has a working group dedicated to finding less expensive fiber solutions. If the latter group succeeds in its efforts, it could encourage use of fiber-based FDDI and somewhat reduce the market potential of UTP products.

In fact, fiber fans insist that its advantages—EMI immunity and inherently higher capacity than copper—will eventually help fiber-based FDDI to prevail. "People are trying to design networks for next generation speeds such as a gigabit per second," notes Bob Fink, head of networking at Lawrence Berkeley Laboratories and chairman of the low-cost-fiber working group. "The bulk of the market in the long run will be fiber."

To reduce the cost of FDDI fiber networks, the working group is focusing on two key devices: transceivers and connectors. Optical transceivers currently cost $300 to $350 but should drop to $70 to $80 within the next year, Fink predicts. The reduction will occur, in part, because his working group will permit FDDI transmitters to be less powerful and FDDI receivers to be less sensitive.

On the connector front, the group will back either an "ST" or an "SC" design. Each is less expensive than the connectors required by the original FDDI specification. The existing specification is simply "overkill," Fink states.

A potential downside to the fiber-based FDDI cost-reduction efforts is a trade-off in performance capability. "Even if customers go with fiber optic, that won't guarantee that they won't have to compromise in the future," cautions Mario Mazzola, chief executive officer of Crescendo Communications, a recent entrant in the non-fiber-based FDDI market. Despite the cost savings, fiber-based networks should be able to support any foreseeable networking requirements, Fink responds. ☐

To get a good idea
of what a great
idea we have in
Image Watches...
paste your
color logo
here.
NEW!
Water-
Resistant
Case

OR EVEN BETTER

Send us your color logo

(Any size letterhead, photo, brochure, artwork which need not be returned)

along with US $14.50 each*

*(Tax, shipping included.)

(special below-cost introductory offer)

and we'll rush you a personalized working *quartz* watch sample as our convincer!

Your company logo in full color on the dial of a deluxe, water-resistant wristwatch. 18K Goldplated case, water-resistant leather strap, battery powered quartz movement with a 1-year no-service-charge warranty (battery included). Men's and women's styles. Remarkably inexpensive even in **small quantities.**

* * * * *

The Image Watches, Inc. staff of 180 people in California are dedicated to serving you with uncompromising product quality, on time delivery and superior customer service.

To dispel any confusion from imitators we stamp our name on the back of each watch.

Please look for this seal of excellence

THIS IS A CREATION OF
©IMAGE
WATCHES,INC
California
JAPAN MOVT

Catalog sheet and details on request.

Limit: 2 samples per company @ $14.50 each

IMAGE WATCHES,™ INC.

Attn: Mr. Salmon

400 S. Atlantic Blvd., Suite 302
Monterey Park, CA 91754
(213) 726-8050

9am - 5pm Mon. - Fri.
Pacific Coast Time

Logo Watch Leader for over 10 Years

©Image Watches,™ Inc.
all rights reserved

Unconditional Money Back Guarantee

adds, the number of workstations with such FDDI links could grow to 500,000 to 750,000. Michael Howard, president of the San Jose-based research firm Infonetics Research Inc., predicts that approximately 500,000 FDDI units of all types will ship during 1994, representing a value of $1.5 billion. More than 60% of these units will be products linking workstations to concentrators, he says, while 40% of the units will represent the more traditional backbone and mainframe type of FDDI applications. Of the workstation-to-concentrator FDDI units, Howard predicts that more than 50% of them will be UTP devices.

Despite the rosy predictions, all parties caution that their estimates assume voice-grade UTP will prove a feasible medium for carrying data at FDDI rates. Although vendors have demonstrated that both shielded twisted pair and datagrade wiring can handle FDDI, questions remain about voice-grade UTP (see "Emission control poses hurdle for copper").

Even if vendors can make FDDI work over voice-grade cable, potential customers won't be able to presume that their existing copper will be up to par. The generic term "voice-grade" encompasses a broad range of wiring types, only a small percentage of which may prove adequate for FDDI's UTP requirements. Because most existing wiring was never graded at the time of its installation, customers will have to test their cables to ensure they comply with any future ANSI standard.

Customers with existing STP wiring face fewer problems, but this type of media is relatively scarce, although five companies—Digital Equipment Corp., Chipcom, Advanced Micro Devices, Motorola, and Synoptics—have a specification for building FDDI adapters that can take advantage of the installed base of STP wiring. "Not a lot of people are beating down our door for STP solutions," concedes Karl Pieper, DEC's FDDI marketing manager. "Everyone wants UTP." ☐

The '92 outlook for chips, telecom, and computers
PAGE 41

Why electronics execs are just wild about Texas
PAGE 89

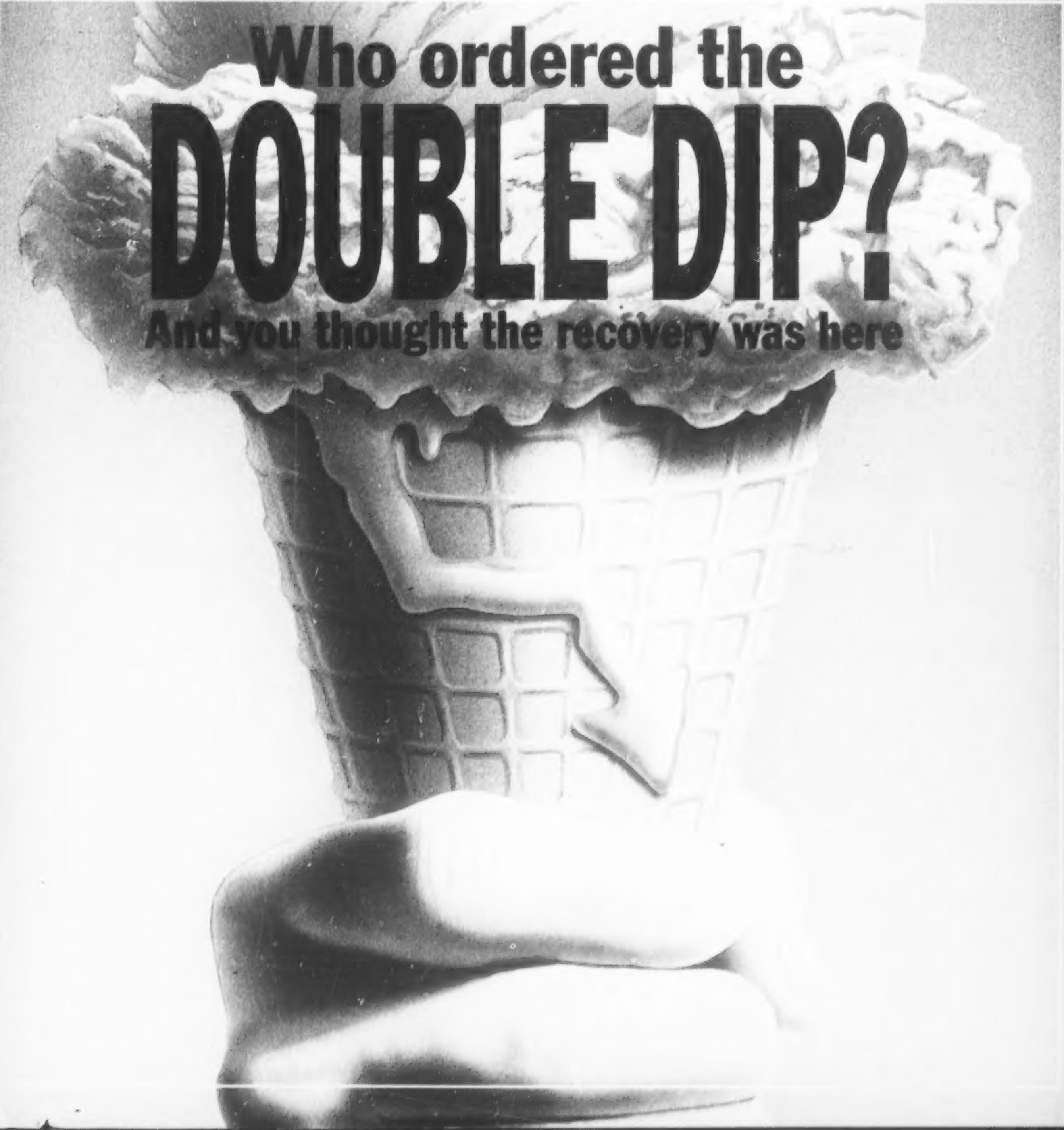
Who will survive the shake-up in graphics boards?
PAGE 93

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

JANUARY 13, 1992



Who ordered the DOUBLE DIP?

And you thought the recovery was here

Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE

VOLUME 18, NUMBER 1

JANUARY 13, 1992

PAGE 32 Electronics shipments continue to melt away

COVER STORY

31 A letter of hope for the weary

32 Shaky consumers and a timid Fed serve up a double dip

Even with government intervention, this year's lackluster recovery will hold electronics sales growth to a meager 5%. An anemic U.S. economy, faltering exports, a downsizing of domestic companies, and small businesses starved for cash will keep the industry in a slump. Says TI economist Vladi Catto: "I've never seen anything like it"

Cover illustration: Tom Szoumowski

UPFRONT

Business Trends

11 Will Japan finally buy American?; Japan's MITI shifts funding from hardware to software; One-stop shopping for chips, passives—and kielbasa?; Toshiba inches toward a U.S. manufacturing strategy; Europe's signals mixed on readiness for frame relay; IBM and Intel: Are two heads better than one?; Turn on your screen and your fax, and say "Ah-h-h"

PAGE 11 Wanted: more local procurement from Japanese manufacturers in the U.S.

Companies to Watch

21 Hal Computer Systems creates high-performance computers based on SPARC architecture; Zeelan Technology makes models from actual components; Nanodynamics develops an X-ray microscope to view tiny chips

Business Barometer

25 **Profits**
Profits improve but are still below normal

26 **Leading Indicator**
Indicator jumps up in October, finally

PAGE 72 Gilbert F. Amelio, chief executive of National Semiconductor

PAGE 83 Cellular sounds good to Europe

PAGE 93 Francisco Nares, a product marketing manager at AST Research

FEATURES

SPECIAL REPORT

41 **Semiconductor vendors pray for 10% revenue growth.** A surfeit of PCs and a surge of competitors plague IC makers

47 **A bleak year for the computer industry** Sluggish sales, falling prices, and shifting buyer attitudes will probably limit revenue growth to 5% in 1992

55 **The end of the slide for passive components** Capacitors, resistors, other devices will show positive revenue growth for the first time in two years, but business is still lousy

61 **Factory automation's price war** Excess capacity and a soft economy pinched sales of electronics assembly gear last year. Few suppliers see relief in 1992

67 **Telecom/datacom vendors gear up for 10% market growth this year** Routers, FDDI, and intelligent hubs will pace the networking market as frame relay transmission boosts speeds for wide area telecom

72 **View from the top** Gil Amelio of National Semiconductor Corp., John P. Morgridge of Cisco Systems Inc., and Tom Meredith of Sun Microsystems Inc. reveal their strategies for success amid the sagging economy

83 **Europe's cellular networks ring bells for U.S. vendors** New competition from the private sector will help boost the number of cellular subscribers by 63% during the next two years

89 **Electronics' new refugees find a haven in Austin** Driven out by high costs and red tape in Boston and Silicon Valley, industry execs see a lot to like in Texas

93 **Shakeout underway for graphics board makers** Last year industry revenue declined 13%, but the worst is yet to come. How to avoid the shakeout

DEPARTMENTS

Inside Business

7 Scouting markets in a shifting landscape

My View

97 Hold out your hand

Company Index

98 Companies covered in this issue

Advertiser Index

99 Advertisers covered in this issue

Viewpoint

100 The recessionary blues: This too shall pass

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editors: David Webb
Assistant Editors: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

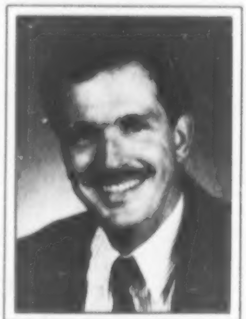
REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices.
Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Scouting markets in a shifting landscape

WHEN WE began planning for this, our market outlook issue, it looked as though the headline would read something like: "What the recovery means to the electronics industry" or "Electronics opportunities in the new growth cycle." But reality seldom matches expectation. The questions that we found ourselves asking about the recovery were not really "how much," but "when" and even "if."



West Coast associate editor David Webb

As senior editor Elizabeth Baatz reports, the autumn decline in overall U.S. economic growth indexes occurred just as the rebound from the recession was expected to begin in earnest. The consensus among Elizabeth's circle of economists and industry sources: The recession is so atypical that the recovery from it will be equally hard to match with conventional models.

Such pervasive uncertainty increases the difficulty of market forecasting; but it also increases the value of careful and conscientious reporting and analysis. In these pages, our editors have given it their best shot, with in-depth looks at the likely future of computers, semiconductors, semiconductor-production equipment, passive components, and European and U.S. telecommunications.

Given the general nail-biting over our economy, these reports include some surprisingly positive news. For instance, assistant editor Barbara Jorgensen finds evidence that makers of passive components may see growth of at least 9% next year, a welcome relief from the past two years. Contributing editor Dwight Davis reports that demand for networking products and systems accompanies the blurring of boundaries between data communications and telecommunications and, as a result, predicts enviable growth for producers of bridges, routers, and intelligent hubs.

Also in this issue, associate editor David Webb surveys the shifting landscape of the graphics board industry. The popularity of Windows applications, along with a host of rapidly emerging technologies, threatens to create a commodity market in VGA products that were not so long ago considered state-of-the-art.

It is not altogether clear how the changing economic landscape will affect the electronics industry. What is certain, however, is that the coming year will contain surprises for many companies and, probably, a new definition of prosperity.

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

BPA ABP

TRADE

Will Japan finally buy American?

FORGET THAT stuff about home being where the heart is. Home is where U.S.-based Japanese companies go when they want electronics suppliers—back to Japan.

According to the American Electronics Association, the tendency to freeze out U.S. suppliers is a big contributor to the U.S.-Japan trade deficit. Japan's Ministry of Trade and Industry (MITI) says, for the Japanese fiscal year ended March 31, 1989, the 156 Japanese electronics companies based in the U.S. sold $16.2 billion worth of goods in the United States. But they bought only $3.3 billion of their supplies from U.S. suppliers, while importing $7.5 billion from Japan. Sourcing those supplies from U.S. manufacturers would make a prodigious dent in the U.S. electronics industry's $18.2 billion 1990 trade deficit with Japan.

Jon McIntosh

Now, the AEA and its Japanese counterpart, the Electronic Industries Association of Japan (EIAJ), are trying to change the hearts and buying patterns of Japanese electronics companies that manufacture in the U.S. by promoting the thousands of U.S. electronics suppliers. That could mean $7 billion or so in extra business for U.S. electronics companies, projects the AEA.

The AEA and EIAJ say they'll try to avoid the politics inherent in any U.S.-Japan dealings. They plan to target specific industries and contact the CEOs of leading companies in those segments as they create local procurement arrangements. The trade groups also established a Tokyo-based group called the "Support Committee to Promote Local Procurement in the U.S."

How effective the effort will be is yet unclear. Those kinds of overtures haven't worked in the past. "We're talking about behavior changes on both sides of the equation," says Bill Krist, AEA's vice president of international trade affairs. They're also talking about upheaval in established Japanese buying patterns.

Arm-twisting by European governments has been more successful in changing Japan's buying patterns there. According to the AEA, Japanese electronics manufacturers in Europe buy 32% of their supplies locally, compared with only 23% local sourcing by their U.S.-based counterparts.

Local procurement by foreign-owned companies expands over time, Krist admits, "but the majority of Japanese companies haven't followed that trend." Despite the cost savings and service benefits associated with local suppliers, he adds, "When U.S. companies call on the Japanese, they often get the cold shoulder."

"More Japanese companies are moving to the U.S. and either purchasing U.S. companies or starting subsidiaries," explains Edward Keible, president of Raychem International in Menlo Park, Calif., chair of the AEA's Japanese trade group. "In instances where the Japanese have purchased a U.S. capital company, they've gradually stopped buying U.S. products and have purchased the products from Japan."

The Japanese need to change that practice, says Krist, but at the same time, U.S. companies need to be more aggressive. "U.S. companies have to recommit to being key suppliers and really go after the Japanese. We've got a Catch-22. We've got to break the circle," he says.

For more information, contact the AEA at (202) 682-9110 or the EIAJ at (212) 489-6270.

—*Willie Schatz in Washington, D.C.*

INTERNATIONAL

Japan's MITI shifts funding from hardware to software

HERE'S THE BAD NEWS: the folks at Japan's Ministry of International Trade and Industry (MITI) are shifting their attention to software—long a Japanese weakness and a vigorous market for the United States. The good news is the MITI-funded software projects likely will include non-Japanese researchers.

MITI has invited non-Japanese to participate in projects before, but few joined because benefits from the na-

MITI funding shifting to software

($ millions)

	Actual 1991 funding	Proposed 1992 funding
Open systems		
Develop open systems software	—	$3.1
Evaluate software R&D environment	—	0.9
Promote OSI	0.2	0.3
Information technology		
Fifth-Generation computer	55.5	27.9
Fourth-Dimension computer	0.7	7.3
New software architecture	1.9	1.9
Regional development		
Regional computer systems	—	110.0
Support technical schools	1.1	1.1
Support regional software capabilities	0.5	0.5
Others		
Develop interfaces for the aged and health information filing	0.7	1.7
Measures against viruses	0.3	0.6
Survey graphic information mgmt.	—	0.1
Survey multimedia networks	—	0.1
Total		$155.5

(Conversion rate: Y130=$1)

*Requested funding, subject to approval

Source: MITI

tionalistic programs seemed limited. But these latest projects have more potential. After years of outside pressure, MITI is aware that openness is in Japan's long-term interest. It also hopes to benefit from outsiders' general software know-how.

The projects target open systems and object-oriented programming that may help make up for Japan's deficiencies in software and are problems of interest to U.S. companies.

U.S. and European researchers are expected to get some of the development money and can pitch their proposals to the administering committee (once it's established) of the Information-technology Promotion Agency (IPA). AT&T has already been in to present its ideas to MITI.

Funding proposals include:

- A $3 million proposal to develop a prototype software program that will allow applications software to run on different operating systems. Initial plans call for focusing on the different Unix operating systems, but the project may expand to other systems as well;
- A project to develop a new software architecture, a kind of object-oriented programming, using modules that adapt themselves to changes in other parts of the program. SRI International joins Japanese researchers working with the IPA, and through SRI a number of European and U.S. university professors are working on the project;
- A $1 million project to spur small Japanese software companies into productivity improvement by using development tools.

Hardware, meanwhile, hasn't been forgotten. Big money is still going to the Fifth Generation Computer project as it winds down, and to its successor, the Fourth Dimension or neural computer project.

—Paula Doe in Tokyo

EASTERN EUROPE

One-stop shopping for chips, passives—and kielbasa?

WAITING FOR AN invitation from Eastern Europe? The government of Poland has appointed a international consortium to advise foreign companies on how they can participate in the privatization of the Polish electronics industry.

The Polish government controls about 25 electronics companies that are larger than $2 million in sales and produce passive and active components, semiconductors, and such finished goods as consumer electronics and telecommunications. The Bain-Moncrieff-Nomura consortium, led by management consultants Bain & Co., will advise potential Polish and foreign investors on what's available to be privatized.

As an electronics market, Poland has some 40 million consumers, making it as large a market as Spain. Its currency is fully convertible, unlike other Eastern European currencies. As a possible manufacturing site, Poland is close to the European Community and has low labor costs and a high skill base, says Jean Baron-Mazloumian, a partner in Bain & Co. in Paris. For information, call him at 011-33-1-45057575; or fax 011-33-1-45051385.

—Barbara N. Berkman in London

STRATEGIES

Toshiba inches toward a U.S. manufacturing strategy

TOSHIBA CORP., long criticized for being the last major Japanese electronics company without a major U.S. manufacturing facility, finally is taking the build-where-you-sell message to heart.

Toshiba, the third-largest chip supplier to the North American market, still hasn't announced plans to build a full-fledged chip fab on American soil, as NEC most recently did. Instead, Toshiba has dipped its toe into U.S. manufacturing with a $20 million-plus plant in San Jose to build high-capacity 3.5-inch disk drives. All products will be designed and engineered there, says Frank Buckley, VP of Toshiba America Information Systems. "Ours is the first fully integrated U.S. division of Toshiba, and upper management is watching us closely. I believe you will see this expanding to other parts of the company."

From a marketing standpoint, the move makes only marginal sense. Analysts wonder how Toshiba—never a force in merchant disk drives—will find a market for the 500,000 units it plans to build by 1993. Its first product, a 1-gigabyte drive, has already fallen behind a pack that includes IBM, DEC, Hitachi, Quantum, Micropolis, and Seagate; once formatted, its drive reportedly runs at only 800-Mbytes.

Manufacturing in San Jose also means higher labor costs and fewer suppliers, since 90% of the world's drives are made in Singapore and Malaysia, notes Philip Devin, an analyst for Dataquest. Currently, only Quantum, Seagate, Hewlett-Packard, and DEC have any volume manufacturing of 3.5-inch drives in the U.S., he says.

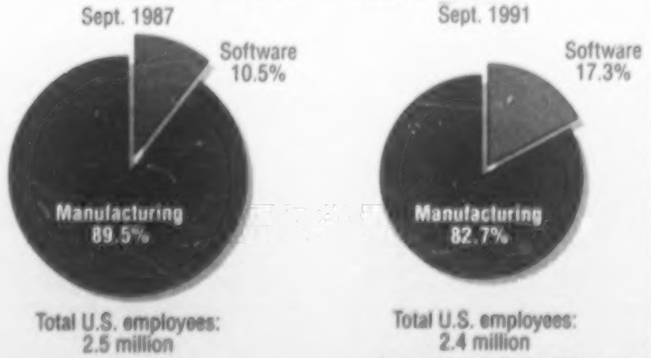
Still, Toshiba stands to gain more than it loses. The move avoids exposing technology or disrupting established businesses while bringing Toshiba closer to workstation and high-end PC makers that use the drives—markets in which Toshiba has not competed in successfully to date.

—Peter Burrows

EMPLOYMENT

Software gets bigger piece of shrinking employment pie

(% share of U.S. electronics industry employment)



Source: American Electronic Association

If the scholars and consultants haven't convinced you of the waning of U.S. hardware, take a look at employment trends. Software employees now account for 17.3% of the total U.S. electronics industry employment pie, up from 10.5% in the fall of 1987. Electronics manufacturers cut their employee rolls 2.8% on average over the last five years, while software houses increased employment at a compounded average annual rate of 12.2%. Thank goodness; otherwise the 90,000 jobs lost in the U.S. electronics sector from September 1987 to September 1991 would have been a lot higher.

—E. B. Baatz

INTERNATIONAL

Europe's signals mixed on readiness for frame relay

IS EUROPE READY for frame relay? This emerging U.S.-invented technology's speed is a viable solution to Europe's expensive telecommunications costs and could ignite some datacommunications markets.

Frame relay is a transmission mechanism technology that accommodates high-speed transfer for data-intensive applications. That's important in Europe, where telecommunications is expensive.

For example, data sent through packet switching stops numerous times en route to its destination: frame relay is the express route. Proponents believe cost savings associated with frame relay's transmission speeds could unleash European demand for videoconferencing and large-file transfers of graphic, image, and CAD/CAM files—perfect applications for frame relay.

Two years of 50%-plus growth in Europe for other local area network interconnection products, such as bridges and routers, has convinced several U.S. companies that believe European demand for high-speed data networks will also fuel sales of frame relay services and equipment.

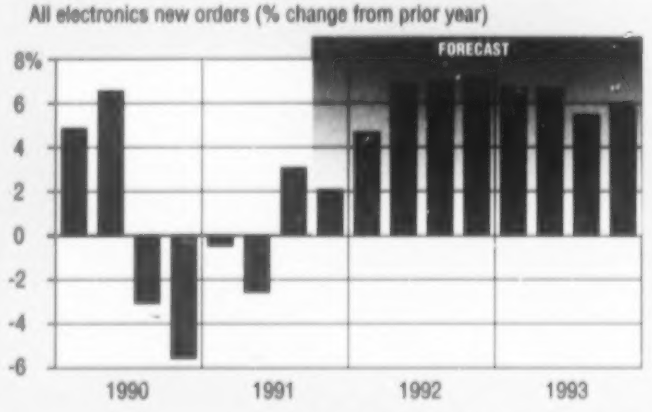
"Frame relay implementations are coming thick and fast from a large range of vendors," says Sean Phelan, an analyst with The Yankee Group Europe. These include BT Tymnet, U.S. Sprint, CompuServe, Nynex, GE Information Services, Hughes Network Systems, and Infonet. IBM expects a September 1992 launch of its European frame relay interface. U.S.-based Teradata will use British Telecom international frame relay for file transfer, accessing in-house e-mail and interaction of corporate databases.

Several obstacles to frame relay remain. Some countries don't yet have the digital link that frame relay requires, and that may not change until Europe goes digital by the mid-1990s. So it would be difficult or impossible to offer pan-European service. Also, some potential customers worry that frame relay only checks for errors at each end of the transmission, while the slower but better established X.25 packet switch checks for errors along the way.

So far, it's been tough to quantify European demand. No sound frame relay market figures exist. Northern Telecom's European arm revised its 1991 market projections for frame relay twice so far.

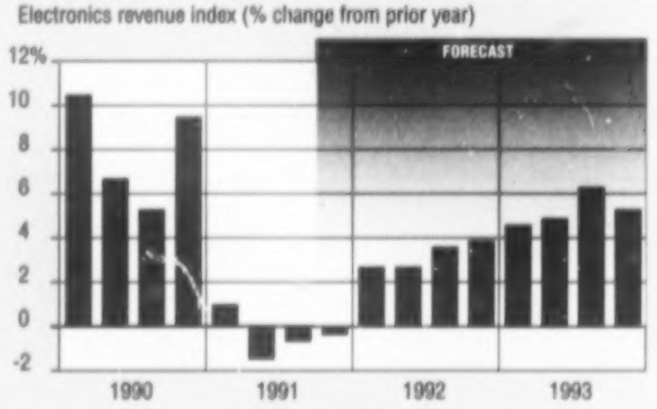
Perhaps the biggest obstacle to frame relay use is that Europe has many small and midsize companies that can turn to the PTTs instead of private networks equipped with frame relay. Telecom Finland was

Demand will climb slowly over next two years...



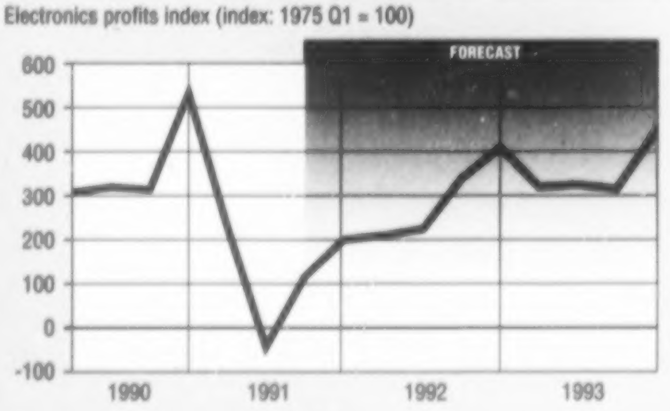
Source: Commerce Dept; forecast: Cahners Economics

...which will help electronics revenue to grow...



Source: ELECTRONIC BUSINESS; forecast: Cahners Economics

...and profits to begin to pull through in 1992



Source: ELECTRONIC BUSINESS; forecast: Cahners Economics

PROFITS

Profits improve but are still below normal

GUARDED OPTIMISM pervades the electronics industry as the ELECTRONIC BUSINESS Profits Index climbed out of the red, from -41.4 (index:1975:QI = 100) in the second quarter of 1991, to 116.6 in the third quarter. That's an improvement, but profits still remain far below industry norms.

The companies in the profits survey noted the recession had spread to both Europe and Japan, dampening foreign demand for their products. Some promising signs do exist, however, as orders for all electronic equipment rose 3.1% in the third quarter of 1990 compared with a year ago. Computer manufacturers are optimistic about sales of smaller network systems and PCs. Cahners Economics expects unit demand for computers to rise slowly through the first half of 1992 before gaining steam toward the end of the year as new product lines enter the market.

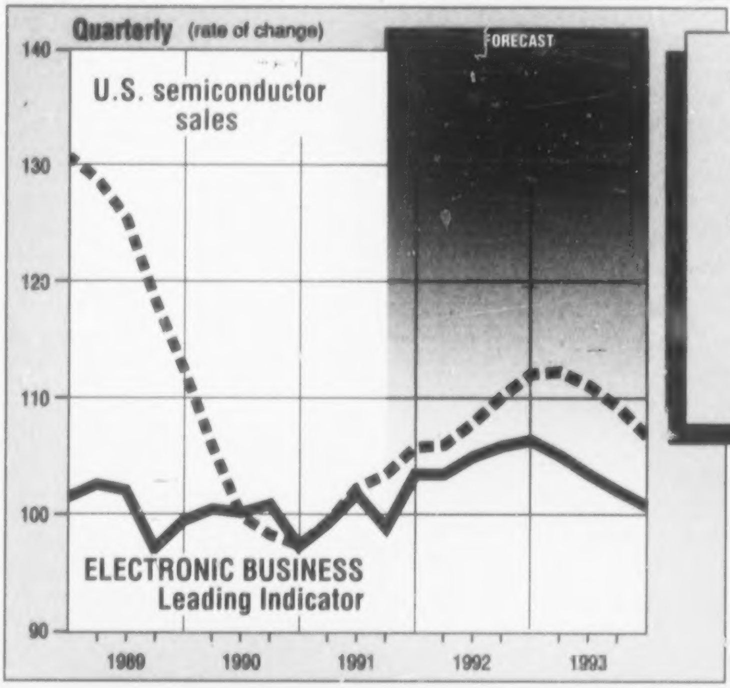
In terms of dollars and cents, the increase in unit demand is not expected to increase revenue substantially until 1993. The ELECTRONIC BUSINESS Revenue Index fell 0.7% during the summer quarter from the previous year, marking the second consecutive quarter of year-over-year declines—the first two-quarter revenue decline in more than 15 years. Expect revenue to increase just 3.3% in 1992 and 5.3% in 1993.

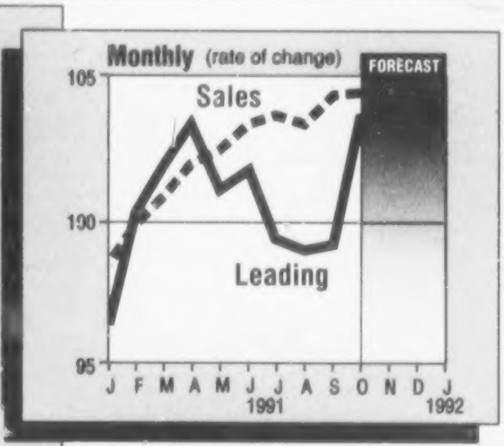
The profits dump has been even more severe than the recent revenue slide. While 1991 quarterly revenues on average held steady at 1990 levels, profits for the year fell back to 1976 levels. Restructuring costs continue to threaten profits this year but will begin to benefit the bottom line by the end of 1992 and provide a bigger payoff in 1993.

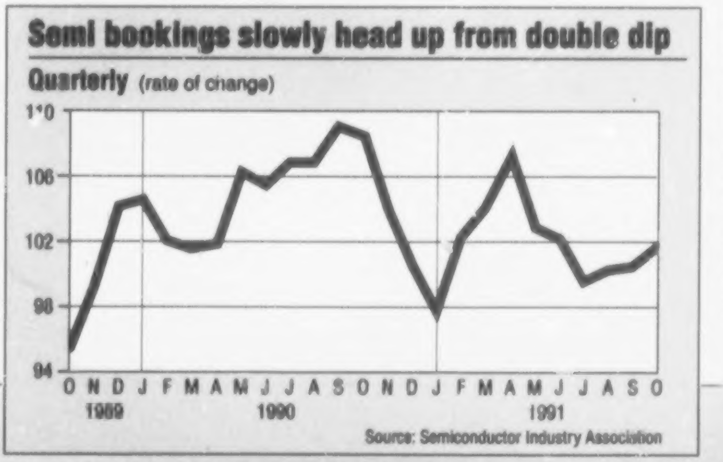
—John Farrell

BUSINESS BAROMETER

ELECTRONIC BUSINESS Leading Indicator







Semi bookings slowly head up from double dip

Source: Semiconductor Industry Association

Indicator jumps up in October, finally

AFTER A DISAPPOINTING summer, the ELECTRONIC BUSINESS Leading Indicator (EBLI) rose strongly to 103.5 in October, from 99.1 in September. Most of the rise was due to increases in both the components lead time and the semiconductor stock price indexes. The most promising sign in October was provided by orders for semiconductors as its quarterly growth rose for the third consecutive month. The EBLI forecast calls for continued growth to a peak of 106.6 in December 1992, which means equipment markets won't hit peak growth rates until mid-1993.

—*John Farrell*

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Oct.)	103.5	99.1	99.3	99.9
U.S. semiconductor bookings ($ millions, 3-month average, Oct.)	$1,252	$1,205	$1,210	$1,254
Weekly hours of semiconductor production workers (monthly average, Sept.)	41.4	40.7	40.7	40.4
Electronic components lead time index (1977 = 100, Nov.)	103.2	89.9	80.5	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, Oct.)	63.4	66.4	52.0	64.6
Change in electronic components inventories ($ millions, SA, Sept.)	-$52	-$75	$50	$33
Contracts and orders for plant and equipment ($ billions, SA, Sept.)	$33.6	$34.2	$38.5	$38.6

SA = seasonally adjusted; all other data are not seasonally adjusted

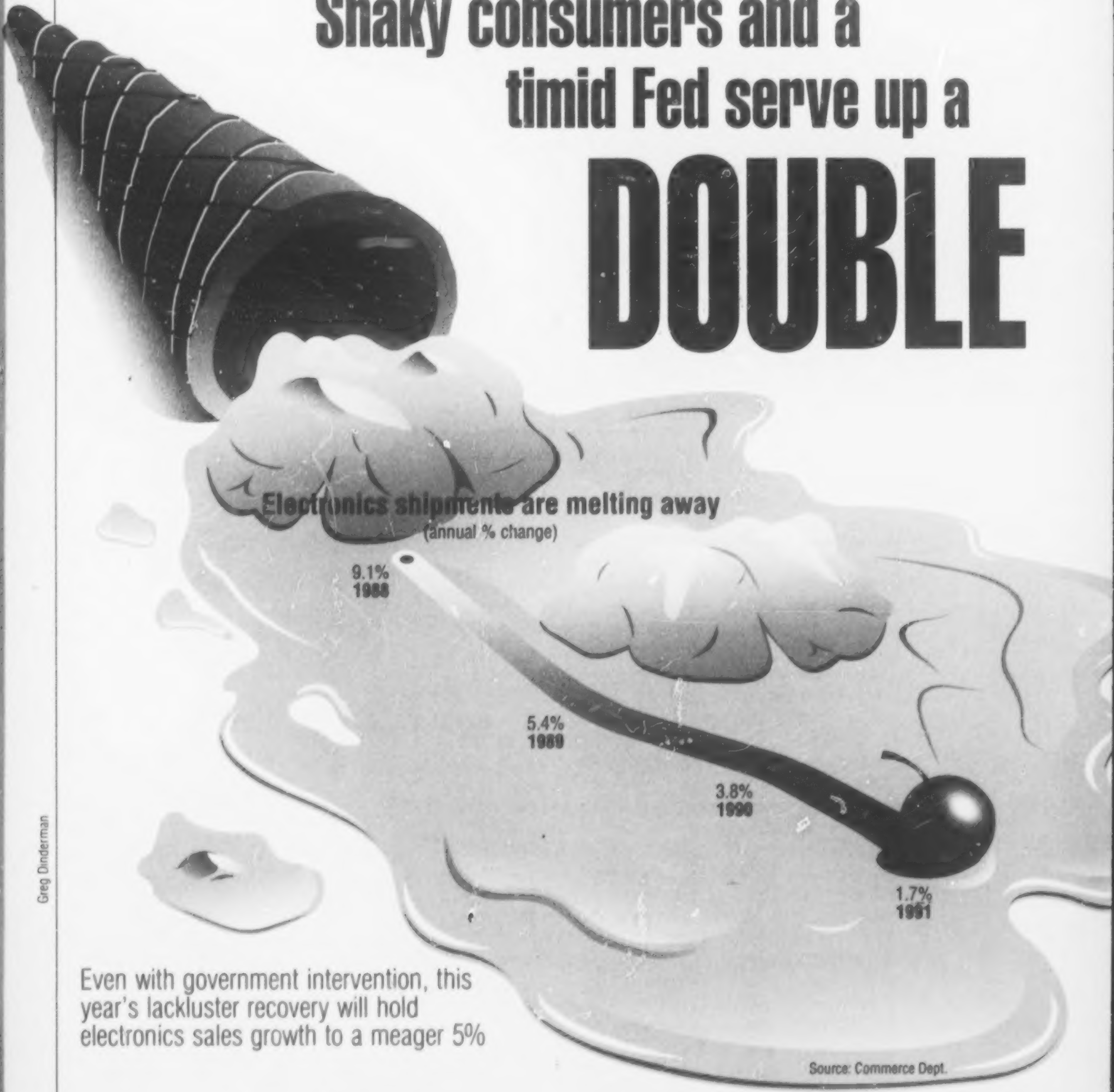
Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100.

ECONOMIC $ OUTLOOK

COVER STORY

Shaky consumers and a timid Fed serve up a DOUBLE



Electronics shipments are melting away

(annual % change)

Source: Commerce Dept.

Greg Dinderman

Even with government intervention, this year's lackluster recovery will hold electronics sales growth to a meager 5%

DIP

By E. B. Baatz

Forget the debate about whether the U.S. economy is in recovery or is stuck in a “double-dip” recession. For many U.S. electronics companies, the real issue this year will be a matter of mere survival. Overall, the U.S. electronics industry will have to scrape by with a sleepy 5% growth rate—a little better than last year, but only about half as strong as during the 1988 recovery and much less than during the 1984 boom.

Blame this year's anemic economic recovery. After an estimated 0.5% decline in inflation-adjusted gross national product (GNP) last year, ELECTRONIC BUSINESS pegs GNP growth at only 1.5% for 1992. (By comparison, GNP rebounded 6% in the first years following the 1974 and 1982 recessions.) The consensus of Robert Eggert's Blue Chip Economic Indicators panel, based in Sedona, Ariz., expects a measly 2.4% GNP growth this year. Their optimism has been slowly eroding: The 53 panelists recently lowered their collective forecast by three-tenths of a percentage point. “The economy has been stagnating since the second quarter of 1989,” says Texas Instruments' chief economist Vladi Catto. “I've never seen anything like it.”

Verifying the accuracy of any forecast will be especially tough this year; the federal government released a major revision to key economic data in December, which will almost surely alter everyone's GNP forecast (see “Government data revisions hide multitude of sins,” page 36).

No amount of fudging, though, will take the sting out of that 5% gain (unadjusted for price changes) in U.S. factory shipments of computers, communication equipment, components, and consumer electronics. Following growth rates of only 1.7% in 1991, 3.8% in 1990, and 5.4% in 1989, that will mean an unprecedented four-year lull for the industry. Not until after this year's elections—when all the attendant tinkering with the economy will have taken hold—will we see significant hiring, inventory restocking, and other sure signs of a rebound.

WHY HAS IT BEEN SO HARD to predict the timing of the 1992 recovery? One reason is that the current business cycle has been anything but typical; the “turning point” that economists usually seek has been hard to find. “It's been so long since we've been in a recovery that no one knows what to expect,” says one corporate economist. “We're all waiting for a V-shaped or even a U-shaped recovery, but in fact we're seeing a saucer-shaped upturn.” Adds Robert Collins, CEO of GE Fanuc Automation North America, “The fundamentals are so different than in the past, that no

The consensus forecast still predicts recovery

(annual percentage change)

	1991	1992
Real GNP	-0.3%	2.7%
Consumer prices	4.2	3.6
Personal income	-0.3	2.4
Industrial output	-1.6	4.0
Business investment	-3.6	2.9
Pretax profits	-1.7	13.4
	(average for year)	
Unemployment rate	6.7%	6.6%
3-month T-bill rate	5.6	5.5

Source: Blue Chip Economic Indicators

one knows what is going to get things going again."

True, turning points have always been notoriously elusive to forecasters. During the last economy-wide recession, most expected a lackluster 1983. When the recovery took hold, however, it was far from mild, especially in the booming electronics industry. But you don't need a crystal ball to see why 1992 looks so gloomy and why a repeat of the mid-1980s upsurge isn't likely:

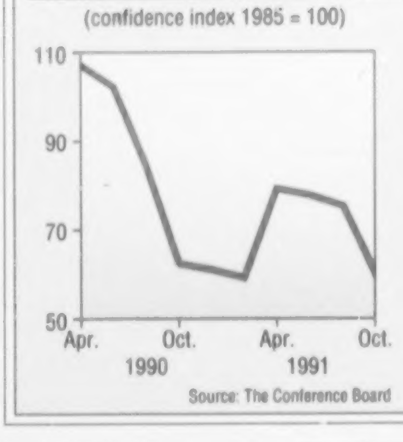
- Consumers are broke. Household net worth fell in 1990 for the first time in two generations, so don't expect housing or autos to fuel a rebound;
- Small business is cash-starved. Start-ups are crippled by a severe credit crunch, and bank financing has been scarce. Even the Federal Reserve's aggressive lowering of interest rates last autumn failed to jump-start the economy;
- Massive corporate restructuring continues. In an attempt to re-position themselves for the '90s, big company execs are sweetening early-retirement deals or laying off employees in droves;
- The U.S. export boom is over. While the Mexican and Canadian economies may be coming up for air in 1992, Japan and Europe are due for economic slowdowns.

"The economy has been stagnating since the second quarter of 1989, says TI's chief economist Vladi Catto

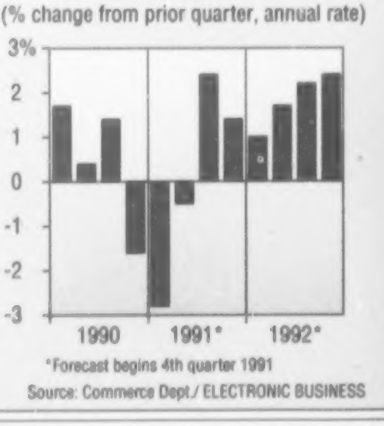
All of that leads Michael Evans of Evans Economics in Washington, D.C., to share the business community's dim outlook. "Businesspeople know more than we do," he says. "The economy has been in the dumps all year long, but the government statistics weren't showing it." Evans, the most pessimistic of the Blue Chip forecasting panelists, calls for just 0.8% GNP growth this year.

That could change if the sputtering consumer-spending engine were to rev up. Consider the biggest consumer purchase: the home. Because of an upheaval in banking and a decline in the rate of household formation, though, new housing starts won't rise much above 1.1 million units in 1992—a far cry from 1986's 1.8 million units. Although short-term rates dropped 3.5 percentage points from August 1990 to October 1991, housing starts fell more than 20%. "That has never happened before," says Evans. "So what is another half or full-point decline in the interest rate going to do? Not much. Most consumers are broke."

That's putting it mildly. Look at household net worth, which had been rising by an average of 8.3% every year since World War II. At that rate, households should have seen their net worth—pegged at $17.3 trillion in early 1990—increase by $1.4 trillion a year later. Instead, falling property values actually slashed net worth by $181 billion—the first decline in two generations. As the *Wall Street Journal* noted recently, consumers are having to save money the old-fashioned way—by not spending their paychecks. That worries economists who are betting on a tax cut and lower interest rates to boost consumer spending. The slide in household net worth will be slowly self-correcting, but that won't help 1992 much.



Source: The Conference Board



*Forecast begins 4th quarter 1991

Source: Commerce Dept./ ELECTRONIC BUSINESS

Defining recessions and double dips

LIKE BASKIN ROBBINS'S 31 flavors, economists have phrases to describe all varieties of economic recessions. At the moment, the "double dip" seems to be on everybody's tongue.

The phrase was coined by a Ford administration official in 1975 and describes a period during which GNP grows for one or two quarters following a recession, then takes another downturn. In the past, double dips have been caused by inventory accumulation in anticipation of a recovery that doesn't materialize. After a quarter or two of inventory-led growth, the cuts that follow force GNP back down. Although unwanted inventory accumulation has not occurred this time, a double-dip recession is still possible—most likely because of low consumer and business confidence.

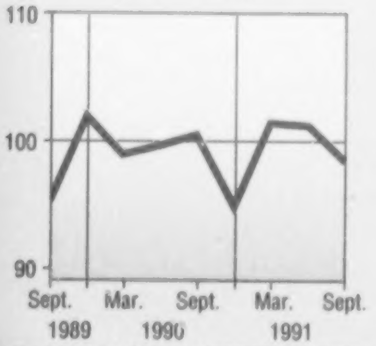
The official arbiter of when a recession ends and a recovery begins is the National Bureau of Economic Research (NBER), a non-profit think-tank in Cambridge, Mass. After poring over reams of complex statistics, the NBER's business-cycle dating committee decides on a recession's exact timing several months to a year or so after the fact.

While waiting for the NBER's decision, business economists resort to a generally satisfactory, off-the-cuff definition: If GNP declines for two or more consecutive quarters, a recession is presumed to have taken place. When GNP starts growing again, the recession is considered to be over. For now, the NBER hasn't decided about the 1991 recession, and economists will continue to argue and speculate about the double dip. ☐

If consumer spending (which accounts for two-thirds of GNP) can't rescue the economy, what about business spending? After a flat spending year in 1991, U.S. business will boost its computer purchases by 4.3% this year, predicts Maddy Franchi, senior economist with Cahners Economics in Newton, Mass. A delayed reaction to lower interest rates and growing need to replace old models will drive the investment. Still, Franchi notes, 4.3% growth means the fourth consecutive year of very slow gains. By comparison, computer spending by business rose 11% in 1988 and 21% in 1984. Despite the fact that automation and modernization of existing factories remains an imperative for global competitiveness, the profit recession that has afflicted U.S. businesses ever since 1988 has put a straitjacket on investment spending.

Nor will inventory restocking add much fuel to the economic fires. In the first 24 months of the 1983-1984 recovery, inventory accumulation added $87 billion to real GNP. Only half as much is likely in 1992 and 1993, which partly reflects a permanent change in corporate inventory policies.

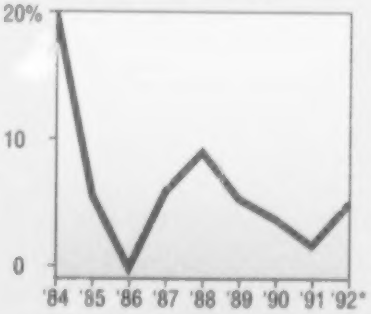
Exports, one of the engines of the 1988 electronics industry surge, is running out of gas too. Japan's powerhouse economy, the number-two market for U.S. electronics exports, actually contracted in late 1991 and is expecting significantly slower growth this year. Germany, the number-four market, is headed for slower growth in 1992 as well. Canada and Great Britain, the number-one and number-three markets, respectively, for U.S. electronics, are expected to have stronger economies this



...and electronics leading indicator shows no hope...

(rate of change)

Source: Cahners Economics/ELECTRONIC BUSINESS



...of much strength ahead for electronics shipments

(annual % change)

*Forecast

Source: Commerce Dept./ELECTRONIC BUSINESS year, but they are slowly emerging from deep recessions the year before. For electronics, a slowdown in exports to Europe will shave a couple of percentage points off 1992 sales growth. "What else is there in the U.S. besides exports to drive an electronics industry recovery this year?" worries Todd Thibodeaux, research analyst for the Electronic Industries Association in Washington, D.C.

Federal or state government spending? Forget it. Even without a tax cut (and certainly with it), the federal deficit is likely to balloon in the next two years. That makes foreign investors nervous and keeps capital-starved domestic businesses at risk. As a result, federal spending, whether for electronic missiles or public works, will face stringent budgets for the next decade. The outlook isn't much better at the state level: About 40 state governments were running a deficit last year. In contrast to Washington, most state and local governments must by law cut spending and/or raise taxes to balance the books. Neither cutting spending nor raising taxes at the state and local government level are likely to stimulate the sluggish economy.

Government data revisions hide multitude of sins

ONE OF THE problems for economists trying to pinpoint economic growth in the year ahead is that history has just been rewritten. Last month, the federal government extensively revised the nation's most important economic statistics: the national income and product account, which tracks GNP, exports, consumer spending, productivity, and other basic economic data. The revisions allowed the Commerce Department to fix old errors of under- or over-counting any particular sectors of the economy.

Among the changes was a re-basing of the inflation-adjusted GNP data from 1982 price levels to 1987 price levels. Because computer prices fell dramatically during those six years, last year's recession now appears to have been deeper than originally reported. As a result, any economic growth this year will seem proportionately stronger. Since the revision conveniently took place just before an election year, reports of economic growth in coming months will favor the incumbents.

The main measure of output is no longer GNP but GDP

The biggest change of all: The government's main economic measure of output of goods and services is no longer gross national product (GNP), but gross domestic product (GDP). The difference is that GDP includes output by all labor and equipment located inside the U.S., regardless of ownership. GNP includes output by all labor and equipment supplied by U.S. residents, regardless of where that property may be located. IBM computers made in Europe are thus included in GNP, but not in GDP.

There are three broad reasons for the new accounting:

- GDP is a more appropriate way to monitor short-term changes in the economy and better corresponds with employment, industrial production, and investment data;
- Most of the U.S.'s major trading partners have adopted GDP accounting, so internation comparisons will now be easier;
- GDP figures should be more accurate than GNP since government estimates of certain GDP components require less guesswork.

The changes offer both a challenge and an opportunity for forecasters. The challenge, says Richard O'Brien, economist for Hewlett-Packard Co., is that "we must know where we have been before we can know where we are going." That's why the forecasts quoted in ELECTRONIC BUSINESS's annual outlook were especially tough to handle this year; the forecasts were all made before the GDP revisions had been announced. The opportunity is that once the data revisions have been absorbed by the economists, their subsequent forecast revisions can hide an assortment of new assumptions. As the cynics know, that means that forecasting errors in the 1992 outlook will be harder to pin down. □

Adding to the uncertainty are fears of a double-dip recession (see "Defining recessions and double dips," page 35). Several recent indicators suggest just that as positive economic signposts after the Gulf war took an unexpected U-turn last autumn. The Commerce Department's index of 11 leading indicators fell in September for the first time since January. Consumers' gains in real disposable income ground to a halt last summer. In the housing market, which had spurred a 25% increase in building permits earlier in the year, permits dropped again by autumn and a late-spring upturn in existing home sales had withered by September.

The challenge, says Richard O'Brien, economist for Hewlett-Packard, is that "we must know where we have been before we can know where we are going"

The electronics industry wasn't immune either. The ELECTRONIC BUSINESS Leading Indicator, a composite of six statistics, had risen from 95.6 in December 1990 to 103.3 by April 1991—not a big jump, but enough to suggest an electronics recovery was in the offing. By September, the indicator had fallen below 100 for the third month in a row. Semiconductor bookings, which had been growing 7% above year-ago levels last spring, were flat again by autumn as well.

Whether the economy is officially on another downturn will be determined when fourth-quarter GNP data is released later this month. If the figures are gloomy enough, says TI's Catto, the Federal Reserve will cut interest rates even deeper and increase the money-supply growth rate. But if the economy shows no clear signs of recession, then the Fed's too-little, too-late reactions could cause a repeat of last year's dismal performance.

Most economists think some type of government intervention is needed to get the economy back into high gear. "If the economy did not pick up in the fourth quarter—and I don't think it did—then Congress will come back in a state of panic this month," predicts Edward Henderson, president of forecasting firm Henderson Ventures in Los Altos, Calif. Henderson figures that will translate into a tax cut that will boost consumer spending.

For most economists, however, human psychology is the wild card in predicting how government policy will impact the economy. "The only thing any of us agree is a positive sign is that next year is an election year and supposedly things are always good during an election year," says Jack Beedle, president of semiconductor forecasting firm In-Stat in Scottsdale, Ariz.

The biggest risk to these forecasts is that fiscal policy, in the form of a tax cut, and monetary policy, in the form of lower interest rates, may not jog the economy quickly enough or strongly enough. For now, the problem is that so few people seem to *believe* in the recovery. Robert Baer, manager of market intelligence at DuPont Electronics in Wilmington, Del., points to the company's current early-retirement plan—only the second in DuPont's history—and the fact that a friend was just laid off at Raytheon. "It just doesn't feel like a rebound," he says. ☐

Economists highlight key factors for the U.S. economy

What are the most favorable factors?

74% said improvement in productivity
67% said lower, more stable inflation and interest rates
62% said export opportunities to Latin America, Europe, and the Pacific Rim
45% said higher savings rate, which will keep capital costs lower
31% said infrastructure rebuilding

What are the most unfavorable factors?

69% said slower labor force growth
62% said the debt overhang leftover from the 1980s
50% said higher taxes, especially state and local taxes
48% said mounting structural costs, such as health care and education
19% said global capital needs, especially in Eastern Europe

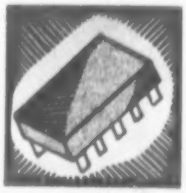
Source: Blue Chip Economic Indicators

MARKET OUTLOOK

Semiconductor vendors pray for 10% revenue growth

But 6% or 7% is more likely as the lingering recession, a surfeit of PCs, and a surge of competitors plague IC makers

By Teri Sprackland



Battered semiconductor manufacturers fear that 1992 could be another bust for the U.S. market. Sales growth is likely to stay stuck in the single digits for the third consecutive year, as overall U.S. sales grow to $16 billion. Single-digit sales growth may be fine for the steel industry, but it's a near-disaster for the semiconductor industry.

Earlier forecasts for 1992, most in the 11% to 15% range, were based on two factors. Most economists predicted an end to this dip in the business cycle in 1991, and President Bush was expected to pressure the Federal Reserve Board to lower interest rates before his reelection bid. The first expectation didn't happen; the second one did, but declining interest rates did not end the slump.

Consequently, fourth-quarter sluggishness has prompted market research firms to hastily revise their forecasts. Estimates for overall U.S. semiconductor makers' sales growth hover in the 6% to 9% range. In-Stat Inc. in Scottsdale, Ariz., predicts 6.7% revenue growth, to $16.1 billion. "The industry may have missed its window for growth in 1992," says James Feldhan, In-Stat's senior vice president.

A surfeit of PCs is the big problem. As they remain unsold, orders for disk drives and other PC peripherals also plummet. "The hard-disk industry is in trouble because it ordered enough chips for 35 million drives in 1991, while only 28 million drives were needed," remarks Marcus Wilson, Intel's general manager of embedded microcomputers.

Even in categories where semiconductor vendor sales are expected to be strong—field programmable gate arrays (FPGAs), processors, and microcontrollers—the growing number of suppliers will depress prices and margins. "Pressure on margins is just the nature of business," because devices that were once proprietary now have multiple sources, notes Ray Farnham, president of National Semiconductor's communications and computing group in Santa Clara, Calif. "Welcome to the real world."

Not surprisingly, buyers love the oversupply. "Semi makers are fighting bloody wars over winning business," says Michael Loftus, vice president of marketing for E-Machines in Beaverton, Ore.

Here's a quick summary

U.S. semiconductor market

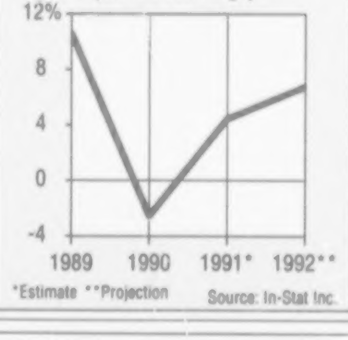
($ billions)

	1991*	1992**	% growth
Total revenues:	$15.08	$16.1	6.7%
Fast-growth segments:			
MPUs and MCUs	3.5	4.2	20%
MOS gate arrays	1.05	1.28	21%
Slow-growth segments:			
Bipolar	.81	.56	-31%
Memory	$4.08	4.3	6%

Source: In-Stat Inc

Overall market growth, 1989-1992

(annual % change)



*Estimate **Projection Source: In-Stat Inc.

Key trends:

- 80x86 processor units up 13%, while revenue climbs 25%
- 4-Mbit memory chip prices may fall 30% due to overcapacity
- FRGA margins deteriorate due to influx of competitors

of expectations for the U.S. semiconductor market in 1992:

- **Processors.** Unit growth of the 80x86 microprocessor family will exactly match PC growth at 12.8%, according to In-Stat. The 386SX and higher devices will account for 95% of sales. The shift to more complex devices will increase total revenue 25%, to $2.6 billion in 1992. Sales of eight-bit microcontrollers, still the largest controller market, will grow 22%, to nearly $760 million in the United States this year, according to In-Stat. RISC devices will grow faster, at 60%, but will account for a relatively small market—around $250 million.
- **Memory.** Revenue of the domestic memory makers will increase about 16%, to $5.3 billion, according to the overly confident prediction of the Semiconductor Industry Association, including a 23% increase in DRAM sales. Industry officials are far less optimistic—stalled demand and new capacity for 4-Mbit DRAMs and delayed interest in the new 16-Mbit DRAMs will reduce overall memory tags by 30% this year, according to Kipp Bedard, vice president of Micron Technologies Corp. in Boise, Idaho.
- **ASICs.** Domestic revenue from gate arrays, programmable logic devices, standard cells, and other ASICs will jump 18% in 1992, to $5.5 billion, according to Integrated Circuit Engineering Corp. in Scottsdale, Ariz. Standard cells and gate arrays will show the largest growth in 1992—more than 20%—while sales of full custom ASICs decline 4%, to $1.1 billion.

RISC chips have matured from the workstation niche to a broader role as controllers in printers and other OEM gear

Advanced technologies represent relatively small markets, but they have by far the largest growth potential. RISC chips have progressed from a specialty item for the workstation niche to a broader role as embedded controllers in laser printers, graphics accelerators, and other OEM gear.

The SPARC chip designed by Mountain View, Calif.-based Sun Microsystems Inc. led the RISC chip parade for CPUs with unit sales of close to 200,000 in 1990, according to In-Stat. This year SPARC should continue its lead over RISC chips such as the R6000 from MIPS Computer Systems Inc. in Sunnyvale, Calif. MIPS recorded 1990 unit sales of around 88,000 chips, says In-Stat.

Embedded applications of RISC chips are expected to boom over the next few years and spur total RISC chip revenue. The Acorn RISC microprocessor licensed by VLSI Technology Inc. in San Jose, which is typically implemented as a standard cell with other functions, remains strong. It had 1990 sales of about 96,000. The 29000 from Advanced Micro Devices Inc. in Sunnyvale, Calif., is likely to gain market share as design wins turn into volume buys; its 1990 unit sales are estimated at 75,000. Intel shipped 43,000 units of its i960 RISC chip for embedded applications in 1990, but volume will soar this year, says Alan Steinberg, i960 marketing manager. "It will be one of Intel's highest growth areas."

Another technology market expected to soar are FPGAs, fueled by OEM buyers' demand for chips that speed their products to market. However, that growth has attracted additional vendors and will pressure prices, says John East, president and CEO of Actel Corp. In-Stat forecasts the worldwide FPGA market to increase 75% this year, to $350 million.

"FPGA competition is coming en masse from two directions—start-up companies and the conventional semiconductor establishment," notes Millard Phelps, an analyst with the investment banking firm Hambrecht and Quist in San Francisco. New products will ship this year from at least three new FPGA vendors using the "antifuse" technology pioneered by Actel: Crosspoint Solutions, QuickLogic, and Concurrent Logic; industry giants such as AT&T, Motorola, and NEC are also expected to join the FPGA battle. The influx of companies will deflate the relatively robust profit margins enjoyed by pioneers to date. "I'm looking forward to the commoditization of FPGAs like I'm looking forward to my next root canal," Actel's East says.

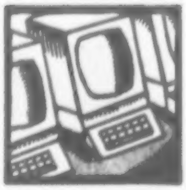
A bright spot is the interest in memory cards. Production will jump from 4 million units in 1991 to at least 52 million units this year, according to SRI International in Menlo Park, Calif. The SIA predicts that flash memory will be an $800 million business worldwide by 1995, or about 3% of the memory market. □

MARKET OUTLOOK

A bleak year for the computer industry

Sluggish sales, falling prices, and shifting buyer attitudes will probably limit revenue growth to 5% in 1992

By Rick Whiting



The computer industry begins 1992 in a mess. Prices and profit margins continue to plunge on desktop and portable computers. Sales channels are in upheaval. Vendors are restructuring and downsizing. Users are confused by the proliferating number of industry consortia, each claiming to have *the* technology of the future. And above the chaos hangs the recession that has kept potential buyers sitting on their wallets.

Although some companies saw feeble indications of an upturn during the third quarter of 1991, 14 of the largest manufacturers of computers and peripheral products, ranging from IBM to Seagate Technology Inc., saw average net profit on continuing operations decline by 72%. Most computer company managers are basing their 1992 plans on the assumption that there will be no real economic recovery until well into the year.

"Only the economists are saying that things are turning around," says Ken Olsen, president of Maynard, Mass.-based Digital Equipment Corp. "The only safe assumption is that things will stay as they are or get worse." Toward the end of 1991, economists and trade groups that had been predicting computer industry growth of 8% to 9% this year were revising their forecasts down to the 5% range.

Even if business remains slow in 1992, analyst Sandy Gant of InfoCorp in Santa Clara, Calif., says computer companies may soon report higher profits for 1991 after trimming their bloated payrolls. John Logan, executive vice president of Boston-based market research and consulting firm Aberdeen Group Inc., expects a turnaround in sales in the second half of the year to push after-tax profits to the 5% range, up from their current 2% to 3%.

The sour economy is not creating the computer industry's woes, only exacerbating such problems as falling computer hardware prices, industry overcapacity, and shifts in customer buying patterns.

The broad price war within the PC industry that began in 1991 is likely to continue, given the availability of 80386 "work-alike" microprocessors, and the OS/2-Windows struggle between IBM and Microsoft Corp., predicts senior analyst William Bluestein of Forrester Research Inc. in Cambridge, Mass. Too

U.S. computer industry

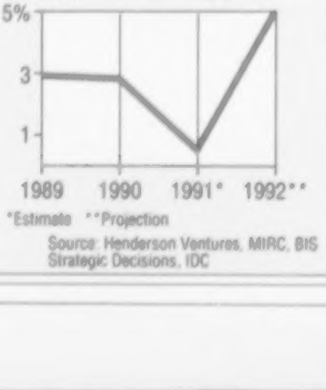
($ billions)

	1991*	1992**	% growth
Total U.S. production:	$56.5	$59.3	5%
Fast-growth segments:			
PCs	24.7	26.7	8%
Workstations	6.8	8.1	19%
Slow-growth segments:			
Mainframes	3.8	3.7	-3%
Midrange	10.9	11.1	2%

Sources: Henderson Ventures, Dataquest, Data Analysis Group

Overall market growth, 1989-1992

(annual % change)



*Estimate **Projection

Source: Henderson Ventures, MIRC, BIS Strategic Decisions, IDC

Key trends:

- Decreasing profit margins on computer hardware
- Increased vendor emphasis on software and services
- Buyers moving toward client-server computing

many products chasing too few customers will aggravate the financial squeeze. "We're in an overcapacity situation, in both the disk drive industry and the PC industry," says Finis Conner, chairman and chief executive of Conner Peripherals Inc. in San Jose. He foresees shakeouts and consolidation in both industries.

Before 1991, PC industry unit sales and dollar volume increased in lockstep. However, the final tally for the PC industry's 1991 performance will likely show that unit sales *increased* while dollar volume *decreased* due to falling prices, says Dataquest Inc. analyst Steve Lair. While he projects unit sales to grow around 5% this year, Lair predicts revenue to be even with 1991 "at best" and perhaps sink a few percentage points.

Street prices on notebook computers, which have plunged 22% in just 12 months, are symptomatic of the pricing and margin pressures being felt by PC makers going into 1992. "Price erosion will continue," Lair says.

Overall sales of desktop computers under $12,000 will grow from $58.6 billion in 1991 to $65.2 billion this year, predicts market research firm BIS Strategic Decisions in Norwell, Mass. Traditional PCs will account for two-thirds of that revenue, workstations 18%, and portables 15%.

Sales of midrange computers will remain lackluster as high-end PCs continue to eat into the traditional minicomputer market. Even sales of computers designed for client-server computing will not take off until more robust client-server software becomes readily available next year, says InfoCorp's Gant. "I'm not optimistic about the midrange market until 1993," she says.

One industry segment that will continue to grow is networking. Attempts by corporations to more efficiently move information among their PCs, mainframes, and midrange computers are boosting sales at companies such as Novell, which sells local area networking (LAN) software, and Cisco Systems, whose products are used to link LANs.

The software industry will also continue the rapid growth it has demonstrated in recent years. Spending for PC software was almost $11 billion last year and will show a compounded average annual growth rate of 14% through 1995, estimates BIS vice president William Ablondi.

Major system vendors such as DEC now see software and services accounting for a majority of their sales in the future, and the revenue contribution from hardware is bound to continue declining this year. □

The hot computer technologies for '92

WHILE 1992 begins with the recession and its impact holding center stage for the computer industry, the new year promises its share of operating system wars, miniaturization, and other developments on the technology front.

Microsoft will debut its Windows NT operating system for PCs while IBM will counter with OS/2 2.0. More software based on object-oriented technology will emerge, BIS Strategic Decisions vice president William Ablondi says, while the first computers compliant with the ACE specifications should make an appearance.

RISC (reduced instruction set computer) will continue as one of the industry's fastest-growing technologies. Later this year, Digital Equipment will introduce its "Alpha" RISC-based line of VAX computers.

Although pen-based computers were trade show darlings last year, 1992 will be the first year that multiple vendors will begin shipping pen-based systems in volume. Industry watchers predict sales in the range of $300 million. Sales of palmtop computers are also expected to accelerate to an estimated $350 million this year.

Expectations that the multimedia market—personal computers that combine audio, video, and imaging capabilities—is about to explode are reminiscent of predictions during the '80s of the always imminent "Year-of-the-LAN." "Where are the standards to make it work?" wonders one analyst. Mountain View, Calif.-based Market Intelligence Research Corp. predicts that multimedia will generate sales of $1.35 billion this year. □

The end of the slide for passive components

Capacitors, resistors, other devices will show positive revenue growth for the first time in two years, but business is still lousy

By Barbara Jorgensen

In September San Francisco-based Electronic Outlook Corp. (EOC) predicted 9.2% domestic revenue growth in 1992 for the passives industry. EOC, considered the leading market research firm covering the component industry, predicted the increase based on a resurgence of orders from the automobile and personal computer industries and a firming of prices due to the continuing consolidation of the industry.

You're not alone if you think that was an overly optimistic outlook for the roughly $12 billion merchant industry. In fact, EOC spent the better part of November scrambling to revise its forecast downward, to 7.8% growth, but industry insiders are even less sanguine. "I don't see the beginning of 1992 as any different from 1991," says Felix Zandman, CEO of $446 million passives giant Vishay Intertechnology in Malvern, Pa. "The industry is in a recession." Historically, he adds, average resistor revenue growth was 3% to 4% per year—6% to 7% in a good year, and zero to minus in a bad one. Last year, he says, "was a minus year." Overall, passives industry officials are more comfortable predicting 5% revenue growth for this year, at best.

Nevertheless, the author of the industry's most highly regarded forecast acknowledges that he is still optimistic about a recovery after two years of decline. "For 1992, I'm predicting a fairly strong positive, although some people are not comfortable with that," says EOC president Ralph Anavy. He defends his forecast by noting that OEMs' inventories—and suppliers' lead times—are unusually low. If business improves and OEM orders pick up, as Anavy expects, passives makers' excess capacity would shrink and lead times stretch. Faced with tightening supply sources, OEMs would cushion themselves by adding inventory.

Even if increased demand does not materialize, market seers insist that industry consolidation will firm prices across the board in 1992 due to the ongoing consolidation of the components makers. Vishay, which has already successfully folded Dale Electronics' and Corning's resistor operations (among others) under its already ample umbrella, announced in September a bid for Sprague's solid-tantalum capacitor and

U.S. merchant passives market

($ billions)

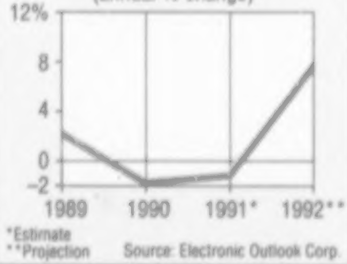
	1991*	1992**	% growth
Total revenue[1]:	$11.5	$12.4	8%
Fast-growth segments:			
PWBs	3.3	3.6	10%
Relays	0.7	0.8	8%
Slow-growth segments:			
Capacitors	2.0	2.1	6%
Resistors	0.9	1.0	6%

[1] Includes connectors, PWBs, capacitors, resistors, switches, and relays

Source: Electronic Outlook Corp.

Overall market growth, 1989-1992

(annual % change)



*Estimate
**Projection

Source: Electronic Outlook Corp.

thick-film network divisions. As domestic competition decreases, passives market share leaders such as AVX Corp. in Myrtle Beach, S.C., and Vishay are expected to be less aggressive on price and more conscious of the bottom line, Anavy maintains.

Key trends:

- Industry consolidation
- Conversion to surface mount
- Miniaturization

Another prop for prices is reduced capacity in some sectors as the consolidation leads to factory shut-downs. Connector maker Augat Inc. in Mansfield, Mass., closed several interconnect plants in November.

Slim profit margins—3% to 5% after tax—also will prompt passives players to raise prices, says Anavy. "Companies are squeezed for profits," he asserts, and he predicts that price increases are coming. Passives makers flatly disagree. "I wish it were so," says a senior official at one passives manufacturer. "Unit growth is definitely going to outpace dollar growth." Indeed, prices for dipped solid-tantalum caps dropped by about 20% last year, according to polls by *Electronics Purchasing* magazine. In addition, attempts by connector makers last spring to boost prices by a mere 2% to 3% failed. Buyers claim that hikes were unsuccessful, as list prices bore small resemblance to purchase prices.

The same price pressure is true for resistors. "I see prices eroding," says Vishay's Zandman, "but not worse than any other year. Prices erode on an average of 3% per year.

The passives industry's price and profits squeeze is due, in part, to a crucial technology shift, in addition to the effects of the recession. Passives makers have spent heavily in response to OEM demands to develop smaller, surface-mountable (SM) components and are eager to recoup their investment.

A few manufacturers report orders are growing 20% to 30% a year for certain surface mount products

In addition, passives makers also had to invest in quality-improvement programs to stay in the game. Ford Motor Co. in Dearborn, Mich., is paring its supplier list to companies that can meet its five-parts-per million failure rate and have global manufacturing capabilities, according to Frank Donovan, supervisor for discrete components purchasing.

Demand for smaller component sizes and SM devices is tremendous. A few manufacturers report that orders are growing 20% to 30% a year in certain SM product lines. Surface mount, or boards using both SM and leaded components technology, will be used for in-house assembly operations 73% of the time by 1995, up from 52% in 1990, according to Berkeley, Calif.-based Technology Forecasters.

Most of the growth in consumption of passives will be in the Far East, thanks in part to the area's early push to SM technology. EOC's Anavy forecasts 40% of the $11 billion world capacitor demand will originate in the Far East by 1995. "The Far East is the fastest-growing market in the world," he says. "U.S. companies must be more aggressive in their efforts to establish themselves in the Far East."

Breaking into the Far East is getting tougher. "It's not too late to get into these markets, but it's more difficult because the long-term players have already established themselves," notes Allan Cole, AVX vice president of sales. "It's tough for newcomers to displace them."

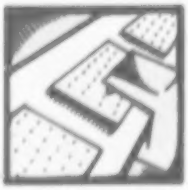
For now, at least, about 25% of the world's capacitor demand is in the United States. Although the Electronic Industries Association estimates ceramic capacitors account for roughly 45% of U.S. capacitor sales, manufacturers report increasing interest from OEMs in tantalum capacitors because they are reliable and stable, despite the price premium relative to ceramic caps. Capacitor sales growth of about 6% is predicted this year for a merchant market of $2 billion, but some players are more optimistic. In fact, 15% growth in capacitors is not inappropriate, claims Dick Knerr, Murata Erie North America's director of market research. Knerr and other optimists are counting on strong growth in automotive, telecom, and computer markets to propel capacitor sales.

As for resistors, EOC calls for 5.6% revenue growth in 1992, producing a merchant market of $1 billion. Industry consolidation, not technology, is having the biggest impact on the resistor market. Vishay has captured an estimated 50% of the U.S. market since 1986 and about 30% of the European market. There's no indication that the acquisitive Vishay, or the overall industry consolidation, will slow anytime soon. □

Factory automation's three-year price war

Customers' overcapacity and a soft economy pinched sales of electronics assembly gear last year. Few suppliers see relief in 1992

By Peter Burrows



Despite headlines about U.S. companies' unwillingness to invest in capital goods, there is a world-class glut of modern production capacity in electronics factories. Competitive pressures on pricing, quality, and efficiency—not to mention the rising complexity and density of PCBs—compelled electronics manufacturers to fill their factories with pick-and-place machines, robots,and other types of equipment to satisfy the market demands of the late 1980s. To no one's surprise, customers' overcapacity set off a painful price war between automation vendors when the economy headed south two years ago. "1990 and 1991 have been terrible years," says Charles-Henri Mangin, president of the market-research firm Ceeris International in Old Lyme, Conn.

Prices have dropped more than 15% for the industry during the past two years, according to Mangin, although new products boast performance that dwarfs their predecessors. Overall unit sales remained flat, but the pricing pressure trimmed revenue from $535 million in 1989 to $500 million in 1991.

U.S. factory automation market

($ millions)

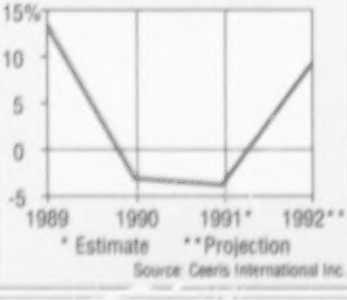
	1991*	1992**	% growth
Total revenues:	$500	$550	9%
Fast-growth segments:[1]			
Aqueous cleaners			
High-speed SMT pick-and-place			
Slow-growth segments:[1]			
CFC-based cleaners			
Through-hole pick-and-place			

[1] revenue breakdown not available

Source: Ceeris International Inc.

Overall market growth, 1989-1992

(annual % change)



* Estimate **Projection

Source: Ceeris International Inc.

Mangin says the market will rebound to $550 million this year if the economy turns around, but most vendors are planning for the worst. "We don't expect any substantial pick-up in 1992," says Ronald Titlebaum, president of Dynapert Inc. in Beverly, Mass. "We're stuck in the capital-spending doldrums, and there's already a lot of excess capacity and used machinery kicking around."

Even the heady market for surface-mount technology (SMT) assembly equipment has felt the chill. The $250 million-plus market for SMT pick-and-place systems bounced along at 30%-plus annual growth during the 1980s as SMT devices began to replace their through-hole predecessors. In 1990 the market dropped by 15%, and has remained the same during 1991, Mangin says.

Given those circumstances, the 1992 goal for most automation vendors is to steal—or at best maintain—market share now and look for profits later. Heavy discounting should continue in most markets, and companies will rely on new products to keep them apace of the competition. "It may be a down year, but we plan to steal 5% to 8% of the market through new products," vows Bill Emery, assistant general manager

Key trends:

- Continued heavy discounting due to weak demand
- $100,000 production cells gaining popularity
- Aqueous cleaners replace moribund CFC-based systems

of Panasonic Factory Automation in Franklin Park, Ill. Panasonic is expanding into new areas such as laser-based inspection and mechanical robots. Market-leader Fuji America, and Sierra Research & Technology, will introduce machines for placement of tape-automated bonding (TAB) devices.

Fuji and Panasonic dominate the high-end of the automation market with highly-integrated turnkey production lines for customers that need both high-throughput and high-performance. These $1 million-plus systems, which often are used as corporatewide SMT job-shops by large electronics manufacturers, can accurately place as many as 24,000 fine-pitch devices per hour, says Mangin. Dynapert, Universal, and Quad Systems also compete at the high-end of the market.

Competitors in less technology-driven strata of the market also are developing broader solutions. They are driving prices down, rather than up, in an attempt to expand unit sales. Vendors, such as Philips Industrial Automation and Zevatech, offer entry-level SMT production cells consisting of a screen-printer, a placement machine, and a solder oven, for around $100,000.

These mini-production lines are the keystone to the vendors' cellular strategy for more volume. Customers are urged to buy multiple copies of the cells and dedicate each one to a specific product. This offers customers closer control over manufacturing processes and fast response when orders arrive, but without the huge cost-per-board incurred with a high-end system. "With prices dropping, the yardstick becomes manufacturing efficiency, not equipment utilization," explains Robin Alan Rhodes, manager of SMT Assembly Systems for Philips. "You don't have to run the line three shifts a day at 13,000 devices per hour to amortize the price tag." Rhodes says Philips enjoyed 15% growth to about $50 million in U.S. sales last year, with sales of these low-end systems providing more than half of the growth.

The 1992 goal for automation vendors is to steal—or at best maintain—market share now and look for profits later

Still, the fastest-growing automation markets are those that offer answers to technical problems as well as added productivity gains. The need for speedy and accurate robots to keep up with the increasing density of boards enabled Lawrenceville, N.J.-based Megamation Inc. to increase orders by 300% in the past year. The $3 million company sells lightweight, small footprint cells that squeeze four independent robot arms into one mechanism, says vice president of marketing Joe Schneider. Four Megamation cells recently replaced 43 robots at Northern Telecom in Research Triangle Park, N.C., and they are setting a fast pace at the factory. "The only problem is that we're still using older [assembly line] feeders, and the Megamations are just wearing them out," notes an NT source.

FOR COMPETITORS WITHOUT such a compelling market driver, the name of the game will continue to be integration. Customers are pushing vendors to provide the peripherals, systems software, and human interfaces necessary to make their production lines more flexible and controllable. "The trend is to get more productivity out of the investment by giving operators more of a chance to interface directly with the equipment," says Robert Collins, CEO of programmable logic controller-maker GE Fanuc Automation North America Inc. in Charlottesville, N.C. Like many other automation vendors, GE Fanuc has added a computer and graphics monitor to new products to meet that need. The ultimate goal? To give supervisors or operators the ability to control and adjust equipment at any place on the production line from a PC or workstation running factory management software.

The trend toward computer-integrated manufacturing is opening up lucrative markets for both software and hardware. Analysts say the market for factory-management software is growing more than 30% a year. Sales of single-board computers and graphics-equipped controllers are growing 14.5% per year, according to Automation Research Corp. in Medfield, Mass. Market Intelligence Research Corp. in Mountain View, Calif., predicts that sales of PCs and workstations into the automation market will grow 10.1% per year between 1989 and 1996, to $8.2 billion. ☐

MARKET OUTLOOK

Telecom/datacom vendors gear up for 10% market growth this year

Routers, FDDI, intelligent hubs will pace networking market as frame relay transmission boosts wide area telecom speeds

By Dwight B. Davis

Overall, the U.S. telecommunications/data communications marketplace should see continued, albeit moderate, growth this year. Select areas in both the local and wide area segments of the business, however, are expected to post gains that other electronics markets will be hard-pressed to match: Even in tough economic times, companies must continue, and possibly increase, their use of networks and communications products.

The North American Telecommunications Association (NATA) pegged the 1990 U.S. market at $35.2 billion in its mid-year 1991 survey of the major telecom equipment markets. At the time, NATA projected that the market would reach $38.4 billion in 1991 and $42.2 billion this year—an annual growth rate of just under 10%. The NATA figures include everything from phone company switches to facsimile machines to local area network (LAN) equipment (see table).

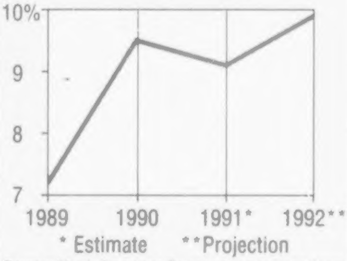
U.S.telecom market

	1991*	1992*	% growth
($ billions)			
Total revenues:	$38.4	$42.2	10%
Fast-growth segments: ($ millions)			
Routers	212	286	35%
Intelligent hubs	544	716	32%
Slow-growth segments: ($ millions)			
LAN equipment	2,210	2,251	2%
Modems	2,785	2,850	2%

Sources: North American Telecommunications Assn.; Dataquest

Overall market growth, 1989-1992

(annual % change)



Source: North American Telecommunications Assn.

Another trend to watch: Distinctions between the phone-based telecom world and the computer-oriented datacom world will continue to blur. One of the hottest growth areas, in fact, will be that of internetworking equipment, which sits at the boundary between LANs and wide area networks (WANs). As LANs have proliferated, the need to transmit data between nearby and distant networks has become acute.

Routers, the premier internetworking devices, must interface with LAN protocols and media on one side and WANs and transmission schemes on the other. In 1990, 11,352 routers, with a total value of $147 million, were shipped in the U.S., estimates Dataquest Inc. This year the market will grow to 26,748 units valued at $286 million.

Router supplier Cisco Systems Inc., which accounted for 36.2% of the 1990 market, should continue to dominate the sector, says Dataquest analyst Marty Palka. Other leading vendors include Digital Equipment, Proteon, Wellfleet, 3Com, and Advanced Computer Communications.

On the LAN front, intelligent hubs will continue to multiply, functioning as central wiring devices with communications spokes radiating out to individual networked devices. Most hubs support various LAN technologies, such as Ethernet, token-ring, and the Fiber Distributed Data Interface (FDDI). They can also house devices such as routers and bridges to link the LANs to campus-wide backbone networks or to WANs.

Last fall, leading hub vendor SynOptics Communications Inc. cut the prices of its 10Base-T Ethernet systems, which should further spur the already brisk market, Palka says. In 1990, the U.S. market for intelligent hubs stood at $381 million, and the shipped devices supported 1.2 million communications ports, according to Dataquest. The market will grow to $716 million this year and will comprise 2.7 million ports.

THIS YEAR SHOULD ALSO SEE the fruition of the 100-megabit-per-second (Mbps) FDDI networking protocol, analysts agree. This month, Crescendo Communications will ship the first FDDI devices designed to run over unshielded twisted pair copper wiring. The price cuts permitted by this non-fiber design, combined with lower-cost fiber-based adapters from Sun Microsystems and others, will make FDDI links to desktop computers economically feasible for many advanced workstation applications. As a result, Dataquest predicts shipments of network interface cards pegged to such workgroup-oriented FDDI networks will rise from a mere 2,113 in 1990 to 43,000 this year.

For FDDI devices of all types—including those connecting desktop devices, host computers, and LANs to LANs—the worldwide marketplace totaled $97 million in 1990, according to market research firm Infonetics Research Inc. This year, the worldwide market will explode to $470 million, the company projects.

FDDI's 100-Mbps speed is of little value in connecting LANs and the much slower WANs. In the WAN world, modems that send data at 19.2 kilobits per second (Kbps) are considered fast, and public data transmission services have topped the 56-Kbps range. Developments are underway to help WANs meet the LANs' internetworking requirements.

Key trends:

- Internetworking equipment will blur the lines between telecom and datacom
- Vendors will use ordinary copper wiring as well as fiber to send data at very high speeds
- Wide area network transmission will be enhanced with frame-relay and Sonet technology

The proliferation of local area networks has led to an acute need for new systems to transmit data between nearby and distant sites

This year, the most visible of the WAN innovations will be a transmission technique called frame relay. A data service that sends individually addressed packets of data to the proper destinations, frame relay has been embraced by public data networks as well as router and other equipment suppliers. After an initial uncertainty, even the Bell Operating Companies are moving to offer the service over their networks.

As a result, a growing number of frame-relay options will appear this year. Most equipment that offers frame relay, and most public carriers that offer it as a service, run the packets at the so-called "T-1" rate of 1.5 Mbps or slower. But frame relay can operate at higher speeds; Cisco Systems, for one, has demonstrated routers running the technology at 45 Mbps.

Last year, its first on the market, frame-relay equipment and services accounted for just $8 million in sales worldwide, says Infonetics president Michael Howard. By 1993, he estimates, the market will grow to $213 million.

A data-transmission service called Switched Multimegabit Data Service (SMDS) will offer speeds up to 155 Mbps but won't be universally available before 1995, analysts believe. Even higher data rates will be possible once the public carriers implement a fiber optic transmission technology called Sonet (Synchronous Optical Network). With a basic transmission rate of 51.84 Mbps and a maximum rate of 2.48 gigabits per second, Sonet-based facilities could support demanding computer networking needs.

Few analysts expect Sonet to be widely installed until the mid-1990s, but Santanu Das, president and CEO of TranSwitch Corp., predicts that the technology will arrive faster than that. TranSwitch designs Sonet integrated circuits and other high-speed communications chips. "Systems vendors are under tremendous pressure from the carriers to provide them with Sonet equipment," Das says. While he agrees that Sonet may not be available worldwide until 1995-96, he says, Sonet "islands" will be available this year for limited-distance, high-speed communications. ☐

Europe's cellular networks ring bells for U.S. vendors

New competition from the private sector will help boost the number of cellular subscribers by 63% during the next two years

By Barbara N. Berkman

The deregulation of Europe's state-controlled telecom authorities (the "PTTs"), the opening of the former Soviet bloc, and an explosion in cellular networks have fueled a boom in European telecom equipment orders that shows few signs of cooling down in the next 18 months.

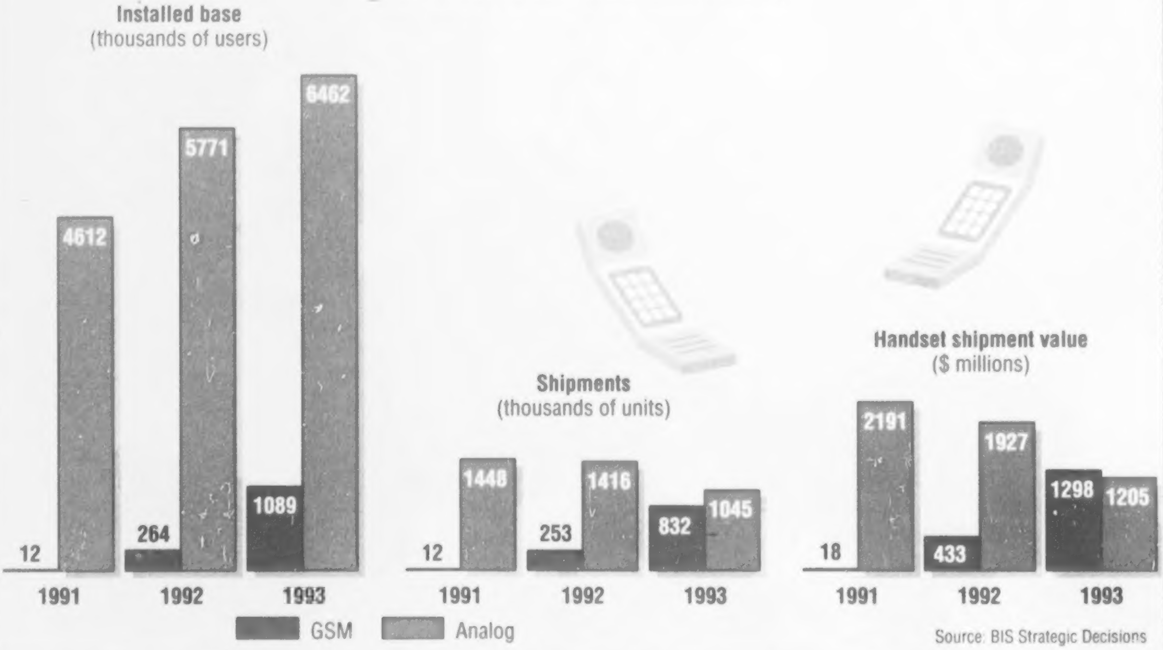
As European governments authorize new mobile networks to compete with those networks run by their PTTs, cellular communications shapes up as the hottest European market opportunity for U.S. telecom equipment companies. The number of Western European cellular subscribers is expected to rise from 4.6 million in 1991 to 6 million subscribers this year and 7.5 million in 1993, according to BIS Strategic Decisions in Luton, England.

The U.S. Baby Bells—especially U.S. West, Nynex, Pacific Telesis, and Bell Atlantic Corp.—have already invested $2 billion in cellular infrastructures in Germany, Portugal, Britain, Czechoslovakia, and Poland, according to Systems Dynamics Ltd. in Rickmansworth, England. Spain, Italy, and Greece are also expected to award licenses to international consortia to build and run mobile networks by 1993.

Basic telecom equipment will be another growth engine in Europe for U.S. companies. By the end of 1992, the 12-nation European Community is expected to spend $22 billion for

Cellular sounds good to Europe

(Analog and digital, Eastern and Western Europe)



Source: BIS Strategic Decisions

public infrastructure equipment (a 1% increase over 1991) and $5.5 billion for PBXs and faxes (a 3.3% hike), according to BIS Strategic Decisions.

OTHER MORE ADVANCED telecom products and services—digital imaging, videoconferencing, multimedia, and the wide area network transmission coding technique known as frame relay—are unlikely to arrive in Europe before the mid-1990s. One reason is that Europe lacks the high-performance, low-cost 1.5 megabit per second (Mbps) digital links that have fed the growth of such services in the U.S. Another is that, for now, bandwidth is relatively scarce and expensive in Europe.

The European cellular market, however, is no piece of cake for U.S. vendors. On the infrastructure side, entrenched European suppliers L. M. Ericsson of Sweden and Siemens AG of Germany pose powerful competition. Despite being the largest cellular-network supplier in the U.S., for example, AT&T Network Systems International has had limited success outside the U.S., except for in the Philippines and South Korea. It was only two months ago that AT&T landed a contract for half the backbone equipment for Germany's second digital cellular network, to be built by Mannesmann Mobilfunk; Ericsson Radio Systems will build the other half.

In handsets, meanwhile, Motorola is the only U.S. heavyweight in the European GSM market. (GSM is the digital European standard that is intended to unify Europe's previously fragmented analog cellular market.) BIS estimates the value of GSM phones shipped should reach $433 million this year (up from only $18 million last year), and $1.3 billion in 1993. Besides Motorola, major prototype handset producers in the still-emerging market include Nokia Mobile Phones and Orbitel Communications. Matsushita is the latest entrant in the field, and industry watchers expect that, within the decade, the Japanese will have a dominant share of the market.

Telecommunications market forecast

Shipments for EC countries
($ millions)

	1990	1991	1992	1993
Fax	2,894	2,999	3,006	2,938
PXB	2,284	2,334	2,501	2,768

Source: BIS Strategic Decisions

GSM is nonetheless a promising growth area—at least for U.S. telecom test equipment makers. Hewlett-Packard Co. pegs the 1992 GSM test market at $100 million. Although HP won't give out sales figures, Roger Kann, HP's program manager for GSM testing in Amstelveen, the Netherlands, says a "significant percentage" of HP's total test sales will be in Europe, partly fueled by GSM testing. HP's competitors include Schlumberger Technologies, Racal, Marconi Instruments, and Rohde & Schwarz. Because the GSM test market is so new, however, it is impossible to nail down market share numbers.

GSM test sales could cool down yet. Manufacturers are waiting to see how the European market accepts GSM and its competing digital cellular technology, PCN, which operates at a different frequency.

AS FOR FAST-GROWING products of the near future, European integration will compel multinational companies to boost their investment in data networks and services that link far-flung operations. U.S. companies selling in Europe should offer products that support managed data networks (MDNs) and other value-added network (VAN) services. European demand for MDN services is projected to grow from $633 million this year to $776 million in 1993, according to Systems Dynamics. Meanwhile, data, image, voice, and videoconferencing services on VANs will generate some $12 billion in revenue in 1995, according to BIS Strategic Decisions, up from $3.35 billion in 1990.

There's a caveat to the robust growth: While the VAN service market is opening in many countries, the sector remains heavily regulated, and the PTTs retain monopolies on many voice, but not data, services.

Another telecom growth area is virtual private networks, or VPNs—public networks that offer services similar to those of dedicated leased private networks, but at a lower cost. The U.S. VPN market grew 42% last year (to $2 billion), according to the Yankee Group. European growth rates are less certain, however. The European market is less developed than the U.S. market, partly because Europe's traditionally diverse switching standards have made it impossible to offer identical VPN services in each European country.

Now a flurry of VPN activity is being driven by Europe's attempt to update its antiquated telephone services. Last year, Sprint International became the first company to attempt to change Europeans' preferences for private networks. Sprint is partnered with Britain's Cable & Wireless and the Dutch PTT, as well as non-European PTTs, to offer VPN international service in Europe with products that are identical throughout Europe, including common switch technology based on Northern Telecom equipment. AT&T is courting other PTTs to set up a rival VPN offering. It already offers interconnection to VPNs run by the PTTs in the U.K., Norway, France, Italy, and Japan.

Despite the recent deal-making in VPNs, Europeans are more receptive to MDNs (in which a network is managed by a third party) and to public network solutions that offer bandwidth on demand. Major U.S. players in the MDN services arena are GE Information Services (the dominant player), Sprint International, and AT&T Corp. Others include the international consortium Infonet and newcomers BT, Cable & Wireless, and France's Transpac. □

TEXAS

Electronics' new refugees find a haven in Austin

Driven out by high costs and red tape in Boston and Silicon Valley, industry execs see a lot to like in the heart of Texas

By Quang Bao

Maybe it was the helicopter ride from the airport that ended in a sun-drenched meadow of bluebonnets. Maybe it was the offer of $20 million in private funds for research. Or maybe it was the lack of corporate and personal income taxes. Whatever the inducement was back in 1983, officials of the new Microelectronics and Computer Technology Corp. (MCC) say they had little trouble winnowing their list of more than 50 U.S. cities to pick Austin, Tex., as MCC's home. Austin's infrastructure, proximity to brain power, and quality of life "made it very hard for us to say no," says Robert Rutishauser, MCC's vice president of finance and administration.

A lot of other executives apparently agree. At last count, more than 1,137 electronics companies operate in Texas, the fourth most popular state for the electronics industry, after Massachusetts, California, and New York, according to the American Electronics Association (AEA) in Washington, D.C. The roster in Austin alone—widely considered the state's most fertile soil for growing high-tech companies—including IBM, Motorola, 3M, Sematech, Cypress Semiconductor, and Advanced Micro Devices. Indeed, total electronics employment increased 13.6% from 1987 to 1990, according to the American Electronics Association (AEA), thanks to relatively low costs and a pro-business environment.

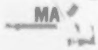
Austin's status as a great place for the electronics industry is a relatively recent phenomenon. During the 1980s, says Rutishauser, a "disorganized" city council seemed to change the rules for electronics companies every day. "Officials got into areas where they didn't know what they were doing," such as controls on chlorofluorocarbon use and shipping, notes John Paxton, regional manager in Dallas for the AEA, who adds that businesses were threatening to leave.

The hostile attitude of politicians toward business changed when Ann Richards moved into the governor's mansion in Austin in 1991. A longtime environmentalist, Richards had been convinced that the high-tech business would destroy the state's land, water, and air. After a lot of education by the industry, however, Richards came to realize that the electronics industry in Austin contributed to the overall financial health of the state. "Electronics was the bad frog that turned into the prince who saved the city," remarks Paxton.

Richards set out to lure businesses to Texas. She dumped Austin's anti-growth city council and slightly eased the tax burden to business. Representatives of the electronics industry, including officials from Motorola and IBM, participate in setting environmental regulations. "Once a company comes here, the city council and the community is willing to help it succeed," says Sylvia Simpson, spokesperson for

Doing business in three states

(1990 data)

	CA	TX	 MA
Number of electronics companies	5,794	1.137	1.380
Number of electronics employees	566.135	164.969	183.482
Electronics employment % change ('85- 90)	-3%	8%	-12%
Electricity costs per kilowatt in cents	09	04	.08
% of state funds spent on R&D	13.1%	6.4%	5.8%
Median home price	$255,000	$95.000	$182.000
Per capita income ($ thousands)	$19.849	$17.945	$22.569

Source American Electronics Association Bureau of Labor and Statistics state chambers of commerce Boston Edison Electric National Assoc of Realtors U S Department of Commerce-Bureau of Economics Dept

Lockheed Missiles & Space Co. in Austin. "Doing business in Austin is like one-stop shopping," adds Ted Pickens, communications director for 3M. "City officials act like your next-door neighbor, and there's always a dialogue between community and government."

THE WELCOME MAT extended by city and state officials presents quite a contrast to the hostile attitudes of other high-tech areas. Consider the experience of San Jose-based Cypress Semiconductor. Its officials received VIP treatment when seeking a location for a subsidiary, Ross Technologies. Cypress CEO T. J. Rodgers recalls that he was greeted at the Austin airport by cheerleaders when he arrived for a site visit in the town of Round Rock, 12 miles from Austin. There, Rodgers received a blank building permit signed by the mayor. The town's hospitality continued after the deal was done as well. "It changed an aluminum wiring code in 48 hours," says Rodgers. "In California, it took more than a year to get approval to put up an awning to keep the rain off my employees."

The relatively low cost of doing business in Texas is another big draw for electronics companies. Not only does the average three-bedroom home in Texas cost almost half its equivalent in Massachusetts, but Austin boasts significantly lower utility rates than San Jose and Boston—4 cents per kilowatt versus 9 cents and 8 cents, respectively. Those kinds of expenses—along with high taxes, unsympathetic government officials, chronic water shortages, and heavy traffic—help explain why electronics industry employment grew 8% per year in Texas while shrinking by 3% in California and 12% in Massachusetts from 1985 to 1990.

A plentiful supply of qualified scientists and engineers also has attracted electronics companies to Texas. Every year the University of Texas, Texas A&M, Rice University, and the University of Houston pump more than 6,000 computer scientists and engineers into the work force. "You don't have to fight for people here the way you do in California," says MCC's Rutishauser.

"You don't have to fight for people here the way you do in California," says Microelectronics and Computer Technology Corp.'s Robert Rutishauser

Austin's schools are doing more than producing bodies—they're producing bodies with the right skills for the electronics industry. "Texas universities have always placed a strong emphasis on science and math," contends Karen Richards, Texas Instruments' education resource manager.

> **"City officials act like your neighbor—there's a dialogue between community and government"**
>
> **Ted Pickens, communications director for 3M**

Academics and industry officials cite a dynamic partnership between the schools and companies in the area as the source of much of Austin's success. "We've got some of the best people in electronics, particularly from the semiconductor industry, on our faculty," contends Ben Streetman, UT professor of engineering and director of the university's microelectronics center. "UT is anchoring Sematech and MCC research efforts, which says a lot about how industry works cooperatively with academics in Austin."

Adds TI's Richards, "the universities are more than just places to job shop—they give us a good perspective on where our market is headed and what strategies TI can use to become more competitive."

As with engineering programs elsewhere, UT's curriculum for engineers is broader than just calculus and physics. Austin's high-technology industry, in fact, actually helps shape the curriculum of engineering classes. "We're teaching statistics and communication skills, since the manufacturing industry demands more than just black-or-white thinkers," says Willis Adcock, a retired TI executive who now teaches engineering at UT.

COMMON ALSO TO state capitals is a steady flow of government-related employment, which has shielded Austin from the downturn in oil and energy prices.

Another draw for companies is Austin's policy of luring new technology companies with state research funds. The $21 million Advanced Research Program, the $41 million Advanced Technology Program, and the $95 million Technology Allotment Fund are designed to match education resources with industry to create a long-range technology plan for the entire state. "We're making a very strong effort to diversify the Texas economy by investing money in our students and researchers," says Dana Chiodo, director of government affairs for Roan, Simpson & Autrey, a law firm that helped to write the legislation.

MCC and Sematech, along with Austin's low costs, cooperative politicians, strong universities, and research funds, provide a thriving high-tech climate. A host of spin-off and auxiliary companies have been created in the area during the past decade. "The expansions or reloca-

And what about the rest of Texas?

AS WITH Austin, Dallas, Houston, and San Antonio are aggressively seeking new high-technology investment to shed their traditional dependence on oil and other cyclical industries. Their relative size and weakened finances give them some advantages—Dallas, San Antonio, and Houston are among the 10 largest U.S. cities—but they suffer from some serious problems as well.

Once almost entirely tied to the petroleum cycle, metropolitan Dallas now attracts a variety of companies and industries. American Airlines, J. C. Penny, LTV, and part of GTE have arrived there during the past few years. Dallas offers free economic planning to relocating or expanding companies. In addition, the "Big D" has embarked on an ambitious program called Interlink to coordinate vocational schools' curricula and the future needs of companies.

Manufacturing has become the *raison d'etre* of San Antonio. With wages running an average of 22% less than in Austin, Dallas, or Houston, a wave of production-oriented electronics companies have located there, including Sony and Fujitsu. Despite its reputation as one of the least expensive cities to do business in, San Antonio is often overlooked by expanding businesses because of its perceived low quality of life and few cultural amenities compared with Dallas and Austin. The city's Chamber of Commerce is working to offset its modest amenities with programs to increase tourism and special efforts to lure new biotechnology companies to the region.

But Houston takes the prize as the most underrated city. The summer weather may be impossible due to the humidity, but real estate prices are cool. Buildings long abandoned by struggling oil and other energy-related companies are irresistible bargains for electronics companies looking for space—leases can be obtained for $9 per square foot in top-quality buildings in metropolitan Houston. The city "hasn't bounced back from the natural-gas price reduction," says Barton Smith, professor of economics at the University of Houston. "If I were an electronics company, I'd move to Houston only because [of low real estate prices]," says Paxton. "Otherwise I wouldn't come." ☐

tions would not have happened if [MCC and Sematech] weren't here," says Angelos Angelou, vice president of the Economic Development Division for the Greater Austin Chamber of Commerce. MCC alone has spawned at least 12 companies, including Evolutionary Technologies Inc., a small company specializing in data integration software.

Numerous entrepreneurial successes have grown out of Austin, including Dell Computer Corp. and CompuAdd Inc. To encourage future entrepreneurs, the UT Graduate School of Business started the Austin Technology Incubator in 1988, matching venture capital sources and professional contacts with high-tech start-up companies. One recent graduate of the program, Rochelle Communications Inc., has developed a caller identification device hooking the PC to the telephone.

In addition to the numerous start-ups, Austin's growing charms have attracted a host of large companies to locate or expand their operations in the area. IBM built a 1.2 million square foot addition to its existing manufacturing facility. Motorola added a $650 million wafer fab plant to its Austin operations. Apple Computer Inc. recently announced a customer support center in Austin, which will create 400 jobs. "IBM and other companies expanding is a key sign that Austin's economy is improving rapidly and coming back strong," says Daniel Van Cleve, state government programs administrator for IBM.

The influx of jobs and other upbeat signs of economic health provide a refreshing lift to life in Austin. Residents have been shielded from the unemployment problems that affected Houston and Dallas: The highest statewide unemployment rate during the 1986 oil bust was 8.9% compared with Austin's 5.6%. In fact, the gloom and doom of New England and the daily traffic hassles of San Jose seem light years away. "The Austin environment isn't deteriorating as it is in other places," says an official from the Environmental Protection Agency in Washington, D.C. The agency says that Austin's air quality was unsatisfactory for 79 days out of 1990, while San Jose's air was considered poor for most of the year—247 days.

Indeed, the style of life in Austin stems from a sense of confidence and well-being. The temperate climate offers an extended season for outdoor activities. Barbecuing and swimming in Barton Springs top Austin's activities list, because the summer is so long—grills are smoking from March to November.

However, the city may not be everyone's idea of heaven. One drawback is Austin Municipal Airport, a rather provincial facility for a city with a population of about 800,000. It offers relatively few direct flights to either coast. Consequently, flying to New York or San Francisco often becomes a two-day ordeal for local executives who usually have to first fly to Dallas or Houston before boarding a plane for either coast.

Another less tangible drawback is the common image of Texas remaining in the frontier mode. "It's hard to convince employees and companies to move here," says Tom Hillman, a human-resource consultant in Austin. "You have to do a lot of selling to push someone who is used to riding in cabs to move to a city where they think the main way to get around is by horse." ☐

Shakeout underway for graphics board makers

Last year industry revenue declined 13% to $627 million, but the worst is yet to come. Can 100 vendors survive a commodity market?

By David Webb

Turmoil in the personal computer market and rapidly changing technologies are brutally shaking out the graphics board industry. Only nimble vendors with leading-edge designs are surviving, while low-end "plain-vanilla" makers of older VGA boards are fading.

More than 100 vendors are still swimming the shrinking waters of the graphics card market, despite forecasts of declines in unit shipments and flat revenue due to intense competition and chip implementations of graphics boards. Last year worldwide graphics board revenues decreased 13%, to about $627 million from $721 million in 1990, according to Jon Peddie Associates in Oakland, Calif. Sales will remain at that level through 1993, but unit shipments will decline by 300,000 to 5.4 million this year and take a 22% dive next year from the shift to chip versionsof VGA. The shakeout "is good news for chip companies and high-resolution board vendors," says Peddie Associates' vice president Fred Dunn. "To low-end VGA vendors, things look pretty bleak. You can always expect that in commodity markets."

Traditionally, shakeouts first claim marginal players in a market, but the consolidation of the graphics board market has been so rapid that an early victim was the leading player just two years ago. Western Digital Corp. in Irvine, Calif., had 50% of the market in 1989 and had among the largest shares of the market in 1990 but completely dropped out of the market last year, largely because of intense price and margin pressures, according to Joan Carrol-Brigham, a graphics board market analyst at International Data Corp. in Framingham, Mass.; company officials declined to comment.

A host of smaller companies such as Genoa Systems Corp. in San Jose are abandoning the low-end of the board market as demand shifts to higher performance graphics. The consolidation "won't be pretty," says Larry Liang, president of Genoa Systems. His company shifted from building unintelligent frame buffer VGA cards to microprocessor-based VGA accelerator boards.

User demand for higher performance graphics to support applications using Microsoft Inc.'s Windows environment and multimedia (full-motion video, audio, and image processing) systems set the stage for the shakeout. Enhanced color processing, higher screen resolutions, and new standards also are behind the market shifts. Only a small pool of vendors of higher-end graphics cards and motherboard chipsets will survive, if they can move fast to remain responsive.

Among the likely survivors are current market leaders ATI Technologies Inc. in Scarborough, Ontario, and Hercules Computer Technology Inc. in Berkeley, Calif. ATI and Western Digital shared some 35% to 40% of the graphics board market in 1990, estimates Jack Roberts, director of Dataquest Inc.'s graphics and display market service in San Jose. Other leaders include Headland Technologies, Cardinal Technologies, Diamond Computer Systems, and Boca Research. Also leading to the

Ed Glendinning

"Rather than buy a board from a board manufacturer, we buy the same chips they do and integrate them on our own -motherboards," says Francisco Nares of AST Research shakeout is the tiny size of many suppliers—only 18 vendors had more than 1% of the market. "Those companies that are dedicated to the graphics board market will stay in there," predicts Roberts. "The low-cost board houses will disappear, and spinoffs of systems-level companies will have a hard time keeping up."

Two types of integration are roiling the market: OEMs adding graphics chipsets to their systems and board makers developing chips for the motherboard. VGA graphics capabilities once available only with add-in boards are quickly being integrated into chipsets that some OEMs are buying and inserting on their motherboards. "Graphics has transformed itself into a strategic part of the business," says Francisco Nares, product marketing manager for CAD systems at AST Research Inc. in Irvine, Calif. "Rather than buy a board from a board manufacturer, we buy the same chips they do and integrate them on our own motherboards." AST's move to integrate VGA chips onto its motherboards also frees a slot on the I/O bus.

Rather than be cut out of the market, some board makers are selling their own single-chip implementations of basic VGA graphics capability. "It's gotten cheaper to make a single chip than an add-on board, and people are demanding the speed you can get with 33 Megahertz on the CPU bus versus 8 MHz on the AT [I/O] bus," notes Shubha Tuljapurkar, vice president of marketing of Headland Technology in Fremont, Calif. Graphics chips that are on the motherboard with its high-speed CPU bus increase the

IBM's days as a graphics standards setter may be over

IBM UNVEILED a passel of multimedia personal computers dubbed "Ultimedia" at Comdex in October but glossed over its next-generation graphics processing architecture, extended graphics array (XGA). That may be an indication that IBM realizes its clout in graphics board architecture and standards is waning, though XGA is expected to ultimately join VGA as a leading graphics standard by 1994.

XGA is a microprocessor-based graphics board architecture. Unlike VGA, which is really a resolution definition, XGA has what San Jose-based Dataquest Inc. analyst Jack Roberts refers to as "true graphics coprocessing capability." Essentially, it incorporates line drawing and bit-block transfer functions into a board-based MPU, relieving the system CPU of those processing functions, and thus allowing faster graphics-processing performance. Line drawing, or refresh, is important in video and complicated design graphics applications. The speed of bit-block transfers is important because the faster they can be performed, the quicker users can jump from window to window of graphics in Windows.

IBM announced XGA in 1990 and licensed SGS-Thomson's Inmos subsidiary to manufacture XGA chips for the merchant market last year. IBM itself has only recently begun to ship XGA chips with Micro Channel bus Model PS/2s. Merchant graphics board vendors aren't expected to jump to build boards around the Inmos chips right away, but analysts expect that over time they will.

The key to XGA's market acceptance—Microsoft Corp.'s Windows environment—also happens to be the reason IBM will lose leadership of future graphics architectural standards. Scores of Windows-based graphics application software packages are being developed for personal computers, and those computers need the power provided by MPU-based accelerator boards and chipsets. Windows users' need for speed is propelling demand for better graphics processing performance to unprecedented levels, not XGA's features themselves. The next-generation graphics market "is really the Windows acceleration market, not XGA," says International Data Corp. analyst Joan Carrol-Brigham. "XGA really doesn't define the market the way VGA did. Windows does more to define the market than XGA or IBM." Adds Francisco Nares, a product marketing manager at AST Research Inc., "Windows is really the standard that everybody will run to [accommodate]; we've seen you can almost ignore IBM."

IBM's graphics standards hegemony is also at risk because XGA is viewed as a weak standard. Although it has an on-board MPU, XGA doesn't provide what Genoa's Liang calls "true color:" 24-bit channels supporting 16 million colors. IBM is working on 16-bit XGA for support of 64,000 colors. In contrast, 8-bit Super VGA only supports 256 colors using 1024-pixel by 768-pixel screen resolution. There's enough performance growth potential in the VGA architecture to allow it to outperform XGA as it stands now, contends John Edeleanu, president of Berkeley, Calif.-based Hercules Computer Technology Inc. As long as Windows users are happy with upgraded VGA, they couldn't care less about the architecture short of a significant price differential. XGA is more expensive, as one would expect.

Nevertheless, IDC's Carrol-Brigham and others say there's enough reverse-engineering and XGA development work going on to conclude that XGA—or a form of it—will be a viable contender as the next generation graphics standard. "XGA is important because it's IBM," explains AST's Nares, "but the fact that IBM stated XGA as a standard doesn't mean it will be one." ☐

Would You Like Reprints Of This Issue?

January 13,1992

Electronic Business

$6.00 per copy.
$5.00 for 50 or more copies.
Prepaid orders only. Make checks payable to CAHNERS REPRINT SERVICES or use your credit card.

$6.00 per copy.

Please send me ______ copies.

☐ Payment Enclosed ☐ VISA

☐ MasterCard ☐ AMEX

Credit Card Number

Signature

Expiration Date

Phone Number

Name

Title

Company

Address

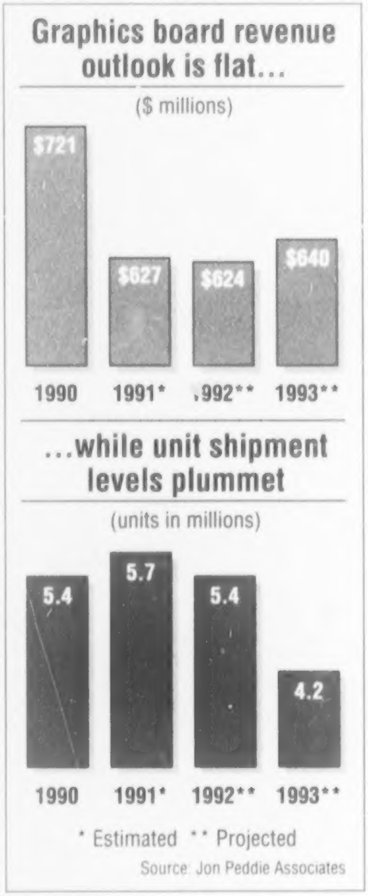
City

State Zip

Send your order to: CAHNERS REPRINT SERVICES, 1350 E. Touhy Ave., Des Plaines, IL 60018 or call Toll Free 800-523-9654 or Fax your order: 708-390-2779

speed of Windows applications by a factor of up to 10.

The integration trend is not new, but the speed of conversion is having a profound effect on the nature of the graphics hardware market. However, analysts predict that the motherboard chipset market is approaching saturation with recent introductions of VGA-on-a-chip implementations by Cirrus Logic Inc. following chipset entries by Texas Instruments, National Semiconductor, Advanced Micro Devices, and others. "One has to ask how long that [migration to motherboard] window will be open," wonders Dunn.


Graphics board revenue outlook is flat...

($ millions)

...while unit shipment levels plummet

(units in millions)

* Estimated ** Projected

Source: Jon Peddie Associates

Graphics board and chip vendors are also discovering that with higher levels of integration, cheap chip-level solutions make the OEM channel more attractive than the conventional end-user retail and value-added reseller channels. "VARs are definitely being squeezed out," says Rob Rykf, Northgate computer's vice president of R&D. "We ship nearly 100% of our units configured with video."

Some board-level graphics vendors discount the extent of the OEM's interest in including graphics boards in their systems. "OEMs don't like to get stuck when the technology moves so fast," insists Genoa's Liang, despite moves by AST, North-gate, and other OEMs to bundle high-end video into their systems. However, other board vendors formerly dependent on dealers and other retail channels see the OEMs as customers, not competitors. Headland, for example, views the OEM market as a growing channel that may one day exceed the retail channels.

Prospects for vendors of high-end products are brighter, although fast-paced. In the past two years, users were faced with four resolution enhancements: VGA, enhanced VGA, Super VGA, and XGA. "You can't be in this business and not expect to move fast," says John Edeleanu, Hercules' president.

IBM's extended graphics array (XGA) is the latest-generation standard for graphics architectures. It emerged as an industry standard with IBM's announcement of XGA chip availability in mid-1991 (see "IBM's PC graphics standard-setting days may be over," page **XX**). Unlike VGA, XGA incorporates a dedicated graphics coprocessor, but industry officials are critical of its limited support for color, modest refresh rates, and other weaknesses.

Hercules and Genoa insist that they can beat XGA's color and resolution performance with software instead of an on-board MPU. "There are extensions to VGA that can beat XGA's performance, hands down," says Hercules's Edeleanu. "We don't see any reason to jump in [with XGA products] right away." ☐

Why ISO 9000 could make or break your company
PAGE 40

Chip makers may get a tax break in '92
PAGE 11

Multichip modules to spawn $18 billion market
PAGE 48

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE
JANUARY 27, 1992

10 companies that are...

Chun P. Chiu
President and CEO
Quality Semiconductor

Davidi Gilo
President and CEO
DSP Group

Eli Harari
President and CEO
SunDisk

David A. Laws
President and CEO
QuickLogic

Gerald Rogers
President and CEO
Cyrix

Even in a flat-footed 1992, these up and comers are poised to call the tune for their markets

PAGE 20

...PUTTIN' ON THE RITZ

Chi-Shin Wang
President and CEO
Integrated Information Tech.

Steve Pittman
Chairman and CEO
nChip

Alex Malaccorto
President and CEO
MiniStor Peripherals

Jin H. Kim
President
PI Systems

David Angel
President and CEO
Information Storage Devices

Electronic Business

VOLUME 18, NUMBER 2

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

JANUARY 27, 1992

Cover photo by Christopher Springmann

Leading our up and coming companies are (standing, left) David A. Laws, president and CEO, QuickLogic; Gerald Rogers, president and CEO, Cyrix; Chi-Shin Wang, president and CEO, Integrated Information Technology; Steve Pittman, chairman and CEO, nChip; Alex Malaccorto, president and CEO, MiniStor Peripherals; and (kneeling, left) Chun P. Chiu, president and CEO, Quality Semiconductor; Davidi Gilo, president and CEO, DSP Group; Eli Harari, president and CEO, SunDisk; Jin H. Kim, president, PI Systems; and David Angel, president and CEO, Information Storage Devices

COVER STORY

20 Puttin' on the ritz

They aren't the industry's biggest, richest, or most profitable companies by a long shot. But we think these 10 up and comers are a solid bet to waltz through a flat-footed market

UPFRONT

Business Trends

11 IC equipment finally in the fast lane?; Contractors are free at last from DOD spending caps; Is a new front emerging in the industrial policy debate?; Why multinationals have the edge on domestic companies

Business Barometer

17 Prices The component price slide is over

PAGE 11 Faster equipment depreciation promises $450 million a year for chip makers

DEPARTMENTS

Inside Business

7 A refreshing look at the future of electronics

Company Index

51 Companies covered in this issue

Advertiser Index

51 Advertisers covered in this issue

My View

52 Training and tools

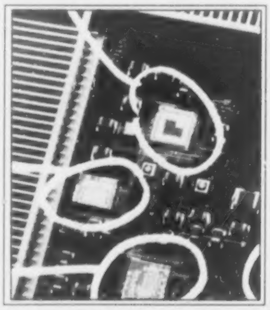
FEATURES

40 Behind the facade of ISO 9000

The biggest threat posed by the emerging global quality standard isn't European protectionism. It's the confusion about what it really means to U.S. electronics companies

48 What are multichip modules and why should you care?

A new form of hybrid IC will be an $18 billion market by the year 2000, as 30% of all chips will be sold as part of a module



PAGE 48 Pacific Microelectronics designed a multichip module for telecom/datacom processing at 622 MHz that includes CMOS, gallium arsenide, and emitter-coupled logic (ECL) die

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editors: David Webb
Assistant Editors: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

E[illegible] BUSINESS articles are available on a [illegible]g basis at reasonable prices.
[illegible]a Marwitz, Cahners Reprint Service,
[illegible] Plaza, 1350 E. Touhy Ave., P.O. Box 5080,
Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

A refreshing look at the electronics future

Senior editor Teri Sprackland

TIRED AND depressed by all those doom-and-gloom forecasts for the "matured" electronics industry? Here's a welcome antidote: the tales of 10 young companies with their fingers squarely on the pulse of the technological future. Yes, Virginia, there is a start-up community.

In writing the cover story for our "Up-and-Comers" issue, senior editor Teri Sprackland covers a broad range of technologies from digital signal processing to multichip modules, and West Coast managing editor Hugh Willett provides a market perspective on the jockeying by chip makers, systems houses, and contract manufacturers for what could become an $18 billion worldwide multichip market.

While Teri found differences in the ranks of up-and-comers, she found agreement on which markets are most worth the risk: videoconferencing, multimedia, and PCs for the "virtual office" of the future. These start-ups also share the same cadre of founding investors. Apparently, start-up fever is hard to shake.

While the up-and-comers try their wings, established U.S. electronics companies are facing a new quality-assurance challenge in what they had hoped would be a booming European market. Senior editor Peter Burrows sets out to clear the air with his story on the ISO 9000 standards adopted five years ago in Brussels and due for implementation this year. He reports that confusion over the standards—not surprising considering the number of nations involved—may be a bigger hurdle than the standards themselves. U.S. companies have been slow to educate themselves about ISO 9000 and are hitting the panic button in fear that certification may give their competitors the edge. Peter's report includes a set of guidelines that executives can use to get a foot in the door.

Another multinational arena is the market for systems integration. European senior editor Barbara Berkman and stateside senior editor Rick Whiting take the measure of that market, both in terms of cash volume and of competitive jostling. And there's plenty of jostling going on, as consultants and OEMs court corporate users with buzzwords like "decentralization" and "client-oriented." In Europe, at least, it appears that OEMs, for all their financial clout, may be crowded out by enterprising consultants who focus on business dynamics as well as the latest hardware and software.

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published twice a month, except monthly in December by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

up networks now operated by the National Science Foundation, NASA, the departments of Energy and Defense, and government laboratories.

Expanding the scope of HPCC will help win public support for the project and encourage the private sector to participate, said Apple Computer CEO John Sculley, current CSPP chairman. "This is building the foundation for the economy of the future," he said. Joining Sculley in presenting the report were Digital Equipment president Ken Olsen, Hewlett-Packard CEO John Young, Cray Research CEO John Rollwagen, and others.

The executives urged that the HPCC initiative include the development of such "enabling technologies" as new computer architectures, communication protocols, software and algorithms, and advanced microelectronics needed to support a broader range of applications for HPCC. Industrial policy advocates have long argued that the government should aid in the development of such technologies to help maintain U.S. competitiveness in world markets. The CSPP maintains, however, that the document is not a proposal for an industrial policy, something long opposed by the White House in general and Darman in particular.

—Rick Whiting

STRATEGIES

Why multinationals have the edge on domestic companies

IF YOU suspected it was true, now a study confirms it. U.S. multinationals during the 1980s grew faster and were more prosperous than their domestic counterparts. Furthermore, the factors that made this a trend in the '80s have become a competitive imperative for the 1990s.

The study of manufacturing companies, conducted by The Conference Board in New York, finds that among all public companies with $10 million or more in sales, multinationals' revenue grew at an 8.8% average annual rate from 1979 to 1989, compared with 5.5% growth for purely domestic companies. Profits were also higher for multinationals—companies with foreign plants or sales—compared with those selling only in the U.S. (see table).

In high-tech, the profit gap was even larger. Electronics and electrical equipment multinationals' profit rate averaged 7.9% compared with 3.7% for domestic companies. Nonelectrical machinery makers, which includes the computer industry, saw multinationals' profit rate hit 8.5% while domestic companies profits stalled at a 2.7% rate.

Why do multinationals prosper so? The outstanding companies in the study, those with above-average growth and profitability, had several common characteristics. The companies were large and had twice the market share of the average company. They were twice as likely to have operations in the fast-growing Pacific Rim. They were much more likely to engage in R&D outside the U.S. Also, the above-average performers were concentrated in the capital goods and the dynamic, competitive electronics industry.

Multinationals accounted for 53% of all companies studied in 1989 and 89% of all worldwide sales, according to Charles R. Taylor, executive director of the Group of Thirty in Washington, D.C., and the author of the study. The 1980s, of course, saw a rapid increase in global activity for a number of reasons. Technology innovations reduced the cost of transportation and communication, and the need to be in local markets in order to influence emerging technology standards became a driving force.

—E. B. Baatz

Multinationals out-perform domestic companies

(Annual averages, 1979-1989)

Industry	Sales growth		Profit rate	
	Multinational	Domestic	Multinational	Domestic
All manufacturing	8.8%	5.5%	9.4%	7.1%
Electronics & electrical	8.4	3.8	7.9	3.7
Computers & nonelectrical	6.9	3.6	8.5	2.7
Instruments	8.3	5.7	8.7	6.2

Source: The Conference Board

RESEARCH AND DEVELOPMENT

R&D superstars sought for annual award

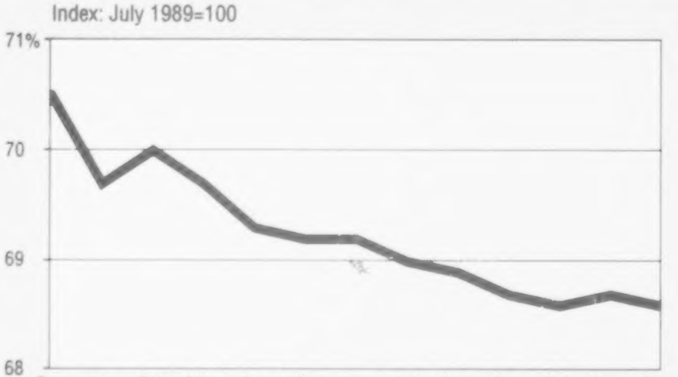
EVER HEAR OF the "zap-out end?" How about the "Telecopier 200 Facsimile Transceiver?" The two products have more in common than the fact that they both went on to become widely recognized by names other than the ones their developers originally gave them.

The "zap-out end" (or pop-top can) and the "Telecopier 200" (or Xerox's original fax machine) were both winners of *R&D Magazine*'s R&D 100 Award. Since 1963, the Cahners Publishing Co. magazine has recognized the 100 most technologically significant new products of the year.

This year, the R&D 100 program is soliciting entries from around the world. Products, which include software, processes, and instruments must have been available for purchase or licensing during the 1991 calendar year. Entries are judged by a panel of scientists, industry experts, and editors of *R&D Magazine*.

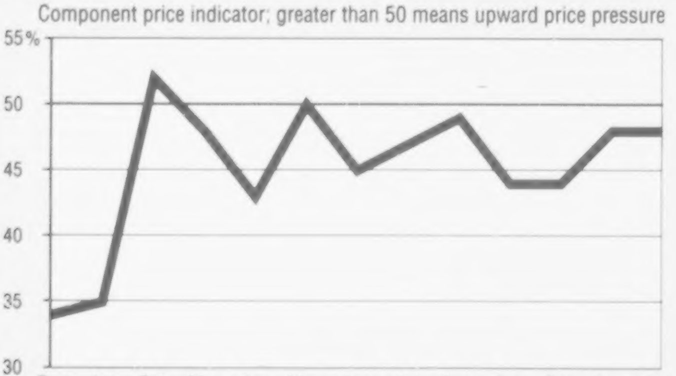
Deadline for entries are Mar. 2, 1992. For entry forms, contact: Ms. Tina Lenz, R&D 100 Coordinator, P.O. Box 5080, Des Plaines, IL 60017-5080 USA; or fax: (708) 390-2618.

Semiconductor prices linger at low levels...



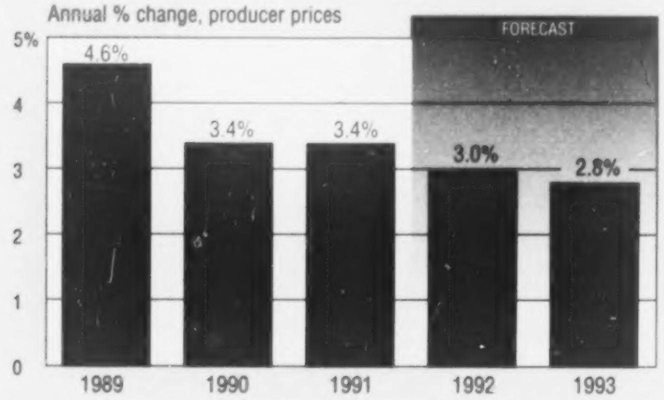
Source: *Electronics Purchasing* magazine

...and downward pressure on price still exists...



Source: *Electronics Purchasing* magazine

...while aggregate inflation remains low



Source: Bureau of Labor Statistics; forecast: Cahners Economics

PRICES

The component price slide is over

THE ELECTRONIC component price slide that devastated many component manufacturers in 1991 appears to be over. A monthly survey of buyers from sister publication *Electronics Purchasing* shows that semiconductor prices held steady last year, albeit steady at record low levels. The semiconductor price index (July 1989 = 100) registered 68.6 in December, the 10th consecutive month the index hung around the 70 mark. The components price diffusion indicator confirms the recent trend of stable prices and suggests that pressure to raise prices still does not exist. The indicator stood at 48 this past December, the seventh consecutive month below 50 (a value less than 50 implies downward pressure on prices.)

One reason why prices won't be heading up anytime soon: Buyers at electronic companies still have no plans to build up inventory; 42% of the survey respondents plan to maintain their current inventory levels and 48% intend to reduce inventory stockpiles over the next 90 days.

Other evidence suggests component prices will most likely remain firm at their current low levels. Shipments of electronic components are forecast to rise 8.7% in 1992. While that's stronger than the 2.5% gain seen in 1991, it's not enough to suggest across the board price increases. Furthermore, operating rates for all manufacturers are currently running at just 78.6%, and are forecast to rise only slightly by the end of this year. Finally, the overall economic environment will not see a resumption of inflation in 1992. In sum, continued price deflation remains a bigger worry than price inflation. For electronic components, at least, with any luck prices will be holding firm in 1992 as they did at the end of 1991.

—*Julie Handelman-Sagan*

PUTTIN' ON THE RITZ

They aren't the biggest or the richest, but these 10 up and comers
are good bets to defy this year's flat-footed market

By Teri Sprackland

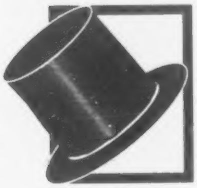
Chun P. Chiu
President and CEO
Quality Semiconductor

Davidi Gilo
President and CEO
DSP Group

David A. Laws
President and CEO
QuickLogic

Gerald Rogers
President and CEO
Cyrix

Steve Pittman
Chairman and CEO
nChip



Many changes have rocked the U.S. electronics industry during the two years since ELECTRONIC BUSINESS last picked its list of "up and coming" companies. The nation has been mired for a year and a half in a particularly stubborn recession that still shows few signs of winding down in the U.S., even as it takes aim on Europe and Japan. Venture capital funding has been slashed by more than half during the past two years, according to one source. Fast-moving technologies have turned yesterday's electronic innovations into the most basic commodities. The industry has been wrenched by slumping sales, plummeting prices, and skyrocketing capital requirements.

The entrepreneurial spirit, however, is far from dead in U.S. electronics (although the cherished image of the "lone rider" has given way to one increasingly shaped by strategic alliances and partnerships). A surprising number of companies, large and small, are being driven to take their new ideas, new end markets, and new applications to the very limits of the technological spectrum. In some cases, successful entrepreneurs have staked their reputations, and their personal fortunes, on

Eli Harari
President and CEO
SunDisk

Chi-Shin Wang
President and CEO
Integrated Information Tech.

Jin H. Kim
President
PI Systems

Alex Malaccorto
President and CEO
MiniStor Peripherals

David Angel
President and CEO
Information Storage Devices

Christopher Springmann

the line. The real problem in putting together this report was not in finding 10 companies that could be described as "up and comers"—it was to keep the number to *only* 10.

Admittedly, none of these companies are guaranteed to succeed in their respective niches, and relatively few are destined to become industry giants. None topped $50 million in sales last year; several of them are only now beginning to ship their first products. Nevertheless, we expect that their proven technological resources, creative positioning in their markets, strong financial backing, and seasoned management teams will have most of them stepping out smartly within the next year or two. ☐

* * *

Cyrix

Richardson, Tex.
Started: 1988
Key Products: Math coprocessor for the x86 PC family

Estimated 1991 revenue: $50 million

Management: Gerald D. Rogers, president, and CEO

Ownership: Berry Cash Southwest Partnership; InterWest Partners III; Sevin Rosen Bayless Borovoy; SRB Partners Fund

Funding: $4 million

Employees: 125

Primary strength: Strong profits from value-added standard product in a big market

CYRIX MADE $25.2 MILLION IN SALES and more than $4 million in profits in 1990, its first year on the market with a math coprocessor that ran at least 20% faster than Intel's. In 1991, sales were expected to close at near or more than $50 million.

Cyrix aims to sell its speedy coprocessor in Japanese markets, according to CEO Rogers

The strategy of targeting Intel is similar to the way in which Compaq went after IBM. Not coincidentally, one of Cyrix's lead investors happens to be L. J. Sevin, who also helped Compaq on its way. CEO Rogers says Cyrix is targeting Japan as a market where it hopes to gain name recognition and stature, because competitor Intel is not as established there as in the U.S.

Cyrix could really make a name for itself if, as industry rumors have said for months, the company introduces a 386-compatible microprocessor to compete with Intel's flagship version. It's not clear just how Intel will react to the move, but if history is a judge, it can be expected to throw up as many legal obstacles as possible. However, Cyrix has not backed away from the challenge yet, and has organized its marketing plan to cope with Intel's well-known propensity to cut prices once competitors enter its markets. ☐

* * *

DSP Group

San Jose, Calif.
Started: 1987
Key Products: Digital signal processing-based chipsets for personal communications

Estimated 1991 revenue: $10 million

Management: Davidi Gilo, chairman, CEO, and president; Shabtai Aldersberg, founder and corporate VP for advanced technology

Ownership: Company employees; Nikko Capital Co.; Kenwood Corp., Poly Ventures; Maruban Corp.

Funding: $12.8 million

Employees: 100

Primary Strength: Excellent partnerships and well-received products in a consumer market with explosive growth projections

DSP Group's Gilo is banking on digital phone-answering machines to keep sales figures climbing

THE DSP GROUP'S product list includes chipsets for cellular telephones, faxes, telephone answering machines, and dictation machines. Sales have climbed from $6 million in 1989 to $11 million in 1990. The company expects to post its first profit this year.

The digital signal processing (DSP) chip market is growing at an annual rate of 36%, according to Will Strauss, president of Forward Concepts, a market research firm in Tempe, Ariz. That well outpaces the growth rates within the overall semiconductor market. Strauss predicts that DSP chip sales will reach $3 billion by next year.

To some extent, the DSP Group's fortunes hang on the future of digital answering machines. Those devices account for less than 5% of the more than 17 million machines sold in 1991 and store only a few minutes of messages. Strauss predicts that as technology improves, the prices of digital machines will plummet, making conventional tape answering machines virtually obsolete by 1995.

The DSP Group's products combine its application specific ICs and proprietary algorithms with Texas Instruments's core DSP and support peripherals. The company's technological expertise in data compression, timescale modification, noise reduction, speech detection and recognition, and echo cancellation have impressed both partners and customers. □

○○○○○

Information Storage Devices

San Jose, Calif.
Started: 1987
Key Products: Nonvolatile direct analog storage chip
Estimated 1991 revenue: $5-$10 million
Management: David Angel, president and CEO; Richard T. Simko, chairman and founder; Michael Geilhufe, founder and VP of manufacturing
Ownership: Applied Technology Partners; ASCII Corp.; AVI Management Partners; company executives
Funding: $8 million
Employees: 20
Primary strength: First to develop nonvolatile analog storage chips

UNIQUELY POSITIONED AS THE only company that has cracked the problem of storing analog signals directly on a floating gate of an MOS transistor, ISD's biggest problem may be deciding which market to pursue first. If costs can be cut as production increases, the company's chips could end up in everything from toys to airport guidance devices. The company has received two patents in analog storage techniques; eight others are pending. Markets now being explored are primarily in communications—pagers, annunciators, and embedded cellular telephone answering/memo devices.

Information Storage Devices' Angel claims the company's chip will stall tape-based and digital phone-answering machines

"I have no doubt that our chip will stall all-digital answering machines while it eliminates tape-recording mechanisms in the mid-range models," says founder Richard Simko, who maintains that the analog chip will be a whole new animal to the technological zoo. Analyst Strauss agrees that the technical achievement is impressive. The next hurdles are to cut the cost of the device and increase the length of the recording from the 20 seconds now possible on each chip. At present, chips can be cascaded to increase storage lengths.

Sanyo Semiconductor Corp. in Mountain View, Calif., has signed on as a customer. Sanyo president Tsuyoshi Taira says he believes the first application in the next year or so will be for the outgoing-message portion of answering machines. ISD is fabless, with several foundry agreements. □

○○○○○

Integrated Information Tech.

Santa Clara, Calif.
Started: 1987
Key Products: Math coprocessor and PC graphics chips; data compression for information storage, video teleconferencing, and multimedia
Estimated 1991 revenue: $30-$35 million
Management: Chi-Shin Wang, president and CEO
Ownership: ASCII Corp.; General Electronics; Mitsui; Yamaha
Funding: $2.8 million
Employees: 100
Primary strength: Strong sales in thriving math coprocessor market. Engineering strength in growth markets in data and video compression

CEO CHI-SHIN Wang proudly points to the fact that his company is the only alternate supplier in Intel's math coprocessor market not to become entangled in legal battles—a definite savings in legal costs compared with other players, such as Cyrix. The company also is working on data compression processors for information storage and retrieval and video compression processors for teleconferencing and emerging multimedia applications. Its latest product is a programmable video signal processor that allows multimedia computer and video communication to be integrated on the same hardware. It also is developing chips for picturephones.

Integrated Info. Tech. is Intel's only rival in math coprocessors to avoid costly legal wars, notes CEO Wang

IIT's biggest customer in its evolving video compression business is market leader Compression Labs Inc. Wen Chen, Compression Labs' executive vice president of R&D, waxes eloquent about the potential of the technology. "The market is mushrooming, becoming a booming area with applications well beyond teleconferencing," he says.

Michael Slater, editor of *The Microprocessor*

Report in Sebastopol, Calif., expects video compression engines to be implemented as add-in boards for PCs in the near future. "If compelling desktop video applications emerge, compression chips could become standard in desktop computers," he says. □

MiniStor Peripherals

San Jose, Calif.
Started: 1991
Key Products: 1.8-inch disk drive
Estimated 1991 revenue: none
Management: Alex Malaccorto, president and CEO
Ownership: Kleiner Perkins Caufield & Byers; Institutional Venture Partners; Grace Venture Corp.
Funding: $12-$14 million
Employees: 70
Primary strength: Well-defined niche in young market, plus strong financial backing to stand up to competition

MiniStor's Malaccorto can expect competition from other makers of high-capacity, small form factor drives

THE YOUNGEST OF this crop of up and comers, MiniStor targets emerging sub-notebook and handheld computer data storage markets. The company plans to later expand into office records storage and undisclosed "unconventional" disk drive markets.

One problem facing the company is that no electronics industry segment is less palatable to investors than disk drives. The sector has been wracked by fierce boom-bust swings that test the G-force limits of new entrants and wreak financial havoc on established ones. MiniStor nevertheless is forging ahead with its large-capacity (60-Mb), credit card-size drives by the third quarter of this year. Watch for plenty of heat from established small-form factor market heavyweights like Conner Peripherals Inc. and Quantum Corp., as well as from start-up Integral Peripherals Inc. in Boulder, Colo., which focuses on low-end 20- and 40-Mb drives. Despite the ferocious competition, the relentless push toward smaller form factors in the high-growth portable PC market is alluring

The company has managed to grab $5.4 million in its first round of venture capital investment, according to CEO and president Alex Malaccorto, and expected another round of up to $7 million before the end of 1991. Kleiner Perkins Caufield & Byers and Institutional Venture Partners each contributed $2 million on the first round; the balance was provided by Grace Ventures Corp. and other minority investors. Malaccorto says the second round would get MiniStor through the pre-production stage, and that an additional $7 million needed by July will put the company into production at a new facility in Singapore. □

nChip

San Jose, Calif.
Started: 1989
Key Products: Multichip modules
Estimated 1991 revenue: $3-$6 million
Management: Steve Pittman, chairman and CEO; Bruce McWilliams, senior VP and chief technical officer; David Tuckerman, VP technology
Ownership: Mohr, Davidow Ventures; Kleiner Perkins Caufield and Byers; Mayfield Fund; Comdisco Venture Leasing Group; Sumitomo Metal Mining
Funding: $11 million
Employees: 50
Primary strength: Ground-floor position in fast-growing, high-volume market. Technical expertise to stay ahead of current customer requirements

MULTICHIP MODULES HAVE BEEN used in mainframes for years. The concept is developing new momentum, however, because faster system clock speeds force microprocessor designers to find ways to improve the speed between chips. Modules provide a substrate technology that improves system performance.

Led by CEO Pittman, little nChip has set out to become a billion-dollar vendor of multichip modules by the year 2000

nChip's customer base includes NexGen, which is working on a 486-performance level microprocessor, and Control Data Corp. Semiconductor companies, including possibly Intel Corp., are working on developing their own capabilities, but there is a niche for an independent supplier who serves customers who want to combine chips from different suppliers onto one substrate. The only company in this year's group to own its own fab, nChip has a San Jose fab with 6,000 square feet of clean room. Because substrate is less demanding in some ways, the company's 2-micron geometry is sufficient and less costly than state-of-the-art fabs, says CEO Pittman.

Dataquest predicts that by the end of the decade, the multichip module business will capture 8% of all chips, with $8 billion from the substrate content. "We plan to be a billion-dollar company, and capture at least 10% of that business, by the end of the decade," says Pittman. Revenue was $5 million in 1991 and company executives predict sales of $10 million to $20 million in 1992. ☐

PI Systems

Portland, Ore.
Started: 1990
Key Products: Lightweight proprietary pen-based computer and software
Estimated 1991 revenue: $28 million
Management: Jin H. Kim, president and cofounder; Chris Rosebrugh, VP engineering/cofounder; Eng-kee Kwang, VP software development/cofounder
Ownership: Asian venture capital, including Tong Yang Group of Korea; private investments
Funding: $5 million
Employees: 26
Primary strength: Lined up to capture a vertical, high-volume mass market

PI SYSTEMS IS ONE OF THE FIRST vendors to introduce a pen-based computer to the market. Unlike other start-ups—such as Momenta Corp., Tusk Inc., and NCR Corp., which target horizontal PC markets—PI is taking aim at modestly high-volume vertical market applications with a low-functionality, pen-based system designed to replace clipboards and paper forms.

Unlike his rivals, PI Systems' Kim targets high-volume vertical markets for his company's pen-based computers

PI's system also weighs much less than the competition—three pounds, versus six- to eight-pound boxes from Momenta and Tusk. Weight is a critical factor in selling systems designed for applications that require it to be lugged around most of the day. PI expects to be in full production this quarter with hardware and software integrated packages selling for under $2,000.

Analysts are convinced that pen-based computer systems will be the next wave of computing as users adapt to the intuitive ease of use of the pen as an input device. By 1995, International Data Corp. predicts, the market will grow to $1.6 billion, up from an estimated $350 million this year. That market will initially grow in the vertical segments targeted by PI. ☐

Quality Semiconductor

Santa Clara, Calif.
Started: 1989
Key Products: High performance CMOS logic, static RAMs, FIFOs, and innovative products packaging marketed to workstation, high-end PC, datacom, graphics, and telecomm markets
Estimated 1991 revenue: $12-$15 million
Management: Chun P. Chiu, president and CEO; Manohar L. Malwah, senior VP technology and manufacturing
Ownership: Employees, private investors, and Institutional Venture Partners
Funding: $9 million
Employees: 70
Primary strength: Experienced management, excellent understanding of Japanese markets, strong engineering talent in high-end SRAM and logic markets

QSI IS ON THE LEADING edge of fast SRAMs, a value-added niche that led companies such as Cypress Semiconductor to fame and glory, as well as high-end logic. The company is now growing into a $1 million a month business.

At Quality Semiconductor, CEO Chiu offers fast SRAMs as an entry into new market niches for the company

QSI's strategy is to go after existing sockets with higher performance parts, then create new niches that can be developed. The company offers higher performance standard SRAMs to get initial orders, for example, then plans to follow with specialty items that solve specific engineering problems and get its parts designed in as a sole source. One new product solves ground bounce problems which are becoming more of a headache at higher clock frequency designs. Markets targeted are mostly in high-end workstations.

Customers include Solectron Corp., a Fremont, Calif.-based 1991 winner of the Malcolm Baldrige Award. Quality Semiconductor is "a very viable competitor," says Jim Handy, senior industry analyst at Dataquest. He notes the founders' expertise from their involvement in the founding of Integrated Device Technology, coupled with their close connections to the Japanese market and leading edge technology. ☐

QuickLogic

Santa Clara, Calif.
Started: 1988 (as Peer Research Inc.)
Key Products: Field-programmable logic devices
Estimated 1991 revenue: $100,000-$500,000
Management: David A. Laws, president and CEO; John Birkner, Andrew Chan, H.T. Chua
Ownership: Sequoia Capital, Sutter-Hill, Technology Venture Investors, U.S. Venture Partners, Vertex Management
Funding: $5 million
Employees: 26
Primary strength: Significantly higher product performance, explosive growth market, experienced management

ONE REASON for QuickLogic's favorable position is its leadership, headed by David Laws, formerly of programmable logic leader Altera. The company was founded by the three men—Birkner, Chan, and Chua—who while at Monolithic Memories Inc. invented what may be the chip industry's most perennially popular product—the programmable array logic.

Can QuickLogic CEO Laws steer his fast programmable logic devices through what shapes up as a crowded field?

Although QuickLogic closed 1991's books with less than $500,000 in sales (all accrued during the last two quarters), Laws claims that 1992 sales will come in at $3 million to $5 million as sales ramp up. He projects a growth path to $15 million in 1993.

QuickLogic's advantage is speed—system performance two to three times faster than competing solutions, based on low impedance antifuse technology called ViaLink. Fab facilities are provided through a manufacturing and technology agreement with ASIC house VLSI Technology Inc. in San Jose. "There is little question that this is the fastest FPGA on the market," says one design consultant.

Despite the successes of other FPGA companies, such as Xilinx and Actel, the latest batch of FPGA companies will have a tough battle. The total market in 1991 came to only about $200 million, according to Dataquest. And Integrated Circuit Engineering Corp., a market research firm in Tempe, Ariz., notes that while FPGAs will grow at a compounded annual rate of about 40% through 1995, the market could support only eight to 10 companies. "I wonder whether the programmable logic market is overfunded," says Richard Helfrich, a founder of Vitesse Semiconductor in Pleasanton, Calif. "We may see some fratricide." ☐

SunDisk

Santa Clara, Calif.
Started: 1988
Key Products: PCMCIA Rev. 1.0 & 2.0-compatible PC cards and modules that emulate disk drives
Estimated 1991 revenue: $3 million
Management: Irwin Federman, chairman; Eli Harari, president and CEO
Ownership: AT&T, Concord, Dillon Read, Mayfield Fund, Oak Investment Partners, U.S. Venture Partners, Western Digital
Funding: $13 million
Employees: 85
Primary Strength: Well designed, low-power disk drive replacement for growing portable PC market

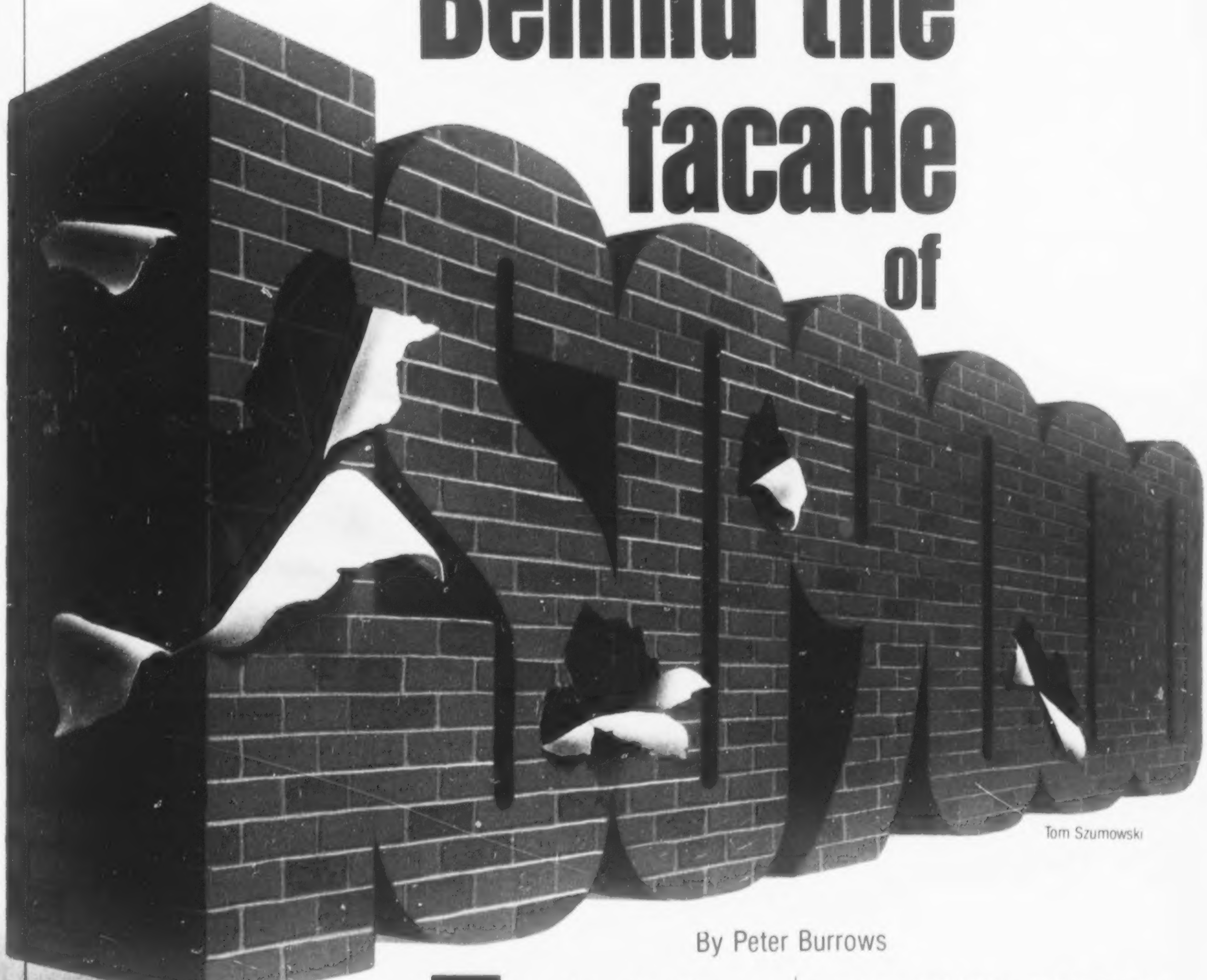
ONE OF THE HOTTEST GROWTH prospects in the computer industry, SunDisk has targeted the emerging PC card interface market with a 10-megabyte capacity memory card. The device appears like a disk drive to the host system but has no moving parts and consumes less power than conventional rotating disk drives. Although its competition could be considered to be conventional disk drives, it provides advantages—low power and ruggedness—that drives can't offer.

SunDisk's Harari thinks the company's memory cards offer important advantages over conventional disk drives

Initially funded by founders Irwin Federman and Eli Harari, SunDisk's first products, shipping now in evaluation quantities, are 10- and 20-Mbyte disk-drive-like storage devices.

Don't call SunDisk a semiconductor company, however—the company provides memory systems that just happen to be packaged chips, says Gib Myers, general partner with the Mayfield Fund and a second-round investor. The company expects to be profitable this year by topping $30 million in revenue. ☐

Behind the facade of



Tom Szumowski

By Peter Burrows

The biggest threat posed by the emerging global quality standard isn't European protectionism. It's the confusion about what it really means

Ever since the European Community (EC) adopted the ISO 9000 quality-system-assurance standards in 1987, skeptics have warned that EC bureaucrats would use the standards to thwart outsiders' efforts to trade with the unified European market after Jan. 1, 1993, when the borders come down.

So far, though, it's been the confusion surrounding ISO 9000, not protectionism, that has hurt U.S. companies most. Although DataSwitch Corp. assured customers that it would be ISO 9000-certified by the EC unification date of Dec. 31, 1992, for example, the Shelton, Conn., company recently lost a seemingly solid $150,000 order for matrix switches with a British government agency to an ISO-compliant competitor. "We thought [the certification process] was proceeding nicely," says president and CEO Robert Gilbertson. "What can you do when the guidelines you are given don't hold up?"

In truth, the guidelines are far more complicated and less predictable than most executives realize. Developed by the 91-nation members of the Geneva, Switzerland-based International Standards Organization (ISO) and adopted as the national quality standard in 41 nations, ISO 9000 certification is required by an ill-defined mix of government buyers and private companies in Europe and elsewhere—either now, by year's end, or at some future date.

THE CONFUSION starts with the standards themselves. Basically, the ISO 9000 standards force manufacturers to prove they can make what they say they will make (see "The basics of ISO 9000"). That sounds simple enough, but there's plenty of room for confusion. For one thing, the standards go by several names—Q-90 in the United States, BS5750 in Britain, and EN 29000 in the EC. Also, there are three different levels of certification: ISO 9001, the broadest, sets quality guidelines for designing, developing, installing, and servicing product. ISO 9002 sets more detailed guidelines for production and installation only. ISO 9003, the least demanding, focuses only on final inspection and testing.

Nor is it clear which products ultimately will require ISO 9000 certification in order to be accepted in Europe. For now, the EC (as well as the seven-nation European Free Trade Association) demand certification only for seven highly regulated products, including toys, safety equipment, and video display terminals. The most troublesome for electronics manufacturers is a directive on telecom terminals that requires that all such products come from ISO 9000-compliant plants by Nov. 6, 1992. The directive defines the terminals as "any device that connects directly to the public networks . . . through direct or indirect connection for the purpose of sending, receiving, and processing information." That could affect 90% of U.S. computer sales in Europe, says consultant Jeff Tuthill of the National Standards Authority of Ireland, an ISO 9000 "registrar" that has recently certified Amdahl Corp. and Prime Computer Corp. Unlike some of the other seven categories, in which requirements may be satisfied by the supplier's internal quality data, the telecom directive calls for actual ISO 9000 certification by an approved registrar.

Eventually, ISO 9000 will become far more pervasive. Britain's Department of Trade now requires that a growing range of products sold to the public sector comply with the standard, and the governments of Australia, Canada, Finland, the Netherlands, Japan, and others are following suit to some degree. NATO and the U.S. Department of Defense will also require ISO 9000 compliance; the Pentagon intends to switch to ISO 9000 from MIL-Q 9858A and MIL-I 45208A by the end of 1993.

There is also a chance that the EC will add to its list of directives. Proposals to require certification for software products and measurement systems are already on the docket.

The real driving force behind ISO-9000, however, is the private sector. Few companies now require suppliers to be ISO 9000-compliant, but many are moving in that direction. A recent poll of 500 electronics purchasing executives by *Electronics Purchasing* magazine shows that, while only 14% now insist on compliance, 66% plan to do so by 1995. "At some point you'll have to be ISO 9000-certified just to stay in the game," says Joel Beck, vice president of U.S. manufacturing with Bull HN Information Systems Inc. in Billerica, Mass., a subsidiary of France's Groupe Bull. "We'll probably ask for it [from suppliers] by the end of 1992 and demand it by the end of 1993."

ALTHOUGH COMPLIANCE isn't mandatory in most cases, it is already a critical differentiator in many negotiations. "We sometimes suggest that vendors get certified," says Hans Pfander, director of quality at ITT Semiconductors in Frieberg, Germany. "We wouldn't choose a supplier just because he has a certificate, but we may choose a supplier that is

The basics of ISO 9000

What is ISO 9000? It is actually a set of standards created by the 91-nation International Standards Organization (ISO) to define the basics of a quality system for manufacturing, including documentation, controls, and worker training. It is not a product certification or quality assurance system and does not replace existing product-specific regulations. Certification is granted on a site-by-site basis, not at the corporate level.

Why is it important? One reason is that the European Community (EC) has made ISO 9000 certification mandatory for certain classes of products, including telecommunications terminals. More importantly, many commercial and government customers (especially in Europe) require compliance from suppliers.

Where does it apply? In addition to product-specific EC directives, the governments of Great Britian, Canada, Australia, and other nations require ISO 9000 certification for certain classes of products. While activity is greatest in Europe, the standard also is gaining momentum in the U.S. and Japan.

How do I comply? The EC's telecommunications directive and many government and commercial companies require that suppliers be certified by a third-party registrar. Other companies permit suppliers to simply demonstrate compliance without third-party certification.

Source: ELECTRONIC BUSINESS

certified over one that is not."

Kris Sateesh, manager of quality control and ISO 9001 programs with GE Fanuc Automation in Charlottesville, Va., confirms that trend. "Nobody requires [compliance] right now, but British Gas and British Petroleum wouldn't buy from us until we showed them a game plan to get there," he says. "Besides, key competitors like Siemens and Philips are getting certified, so we felt we had to do it."

That's the rub facing U.S. electronics companies, especially those whose products fall on the margins of the telecom directive. Although no one can be sure that ISO 9000 will hurt non-compliant vendors, the uncertainty compels many companies to cover their bases just in case. "The real question companies must ask themselves is, 'Am I willing to take the chance when my competitors are moving ahead with it?'" says Mike Caruso, quality and reliability manager at Underwriters Laboratory Inc. in Melville, N.Y., which is now working with more than 200 companies seeking ISO 9000 certification. "If they wait to get registered and find out later that they need to redesign their quality system, it could take them years to catch up."

Considering the relatively low fees charged by registrars (from about $4,000 for a small facility to $30,000 or more for large, multilocation operations), ISO 9000 certification is relatively cheap insurance against such a scenario.

DataSwitch lost a seemingly "secure" U.K. contract to an ISO-compliant rival last year, claims president and AEA chairman Robert Gilbertson

Possibly, the best reason to seek ISO 9000 certification, however, is the reason the standard was developed in the first place—to improve quality. "We invariably reduce our scrap, improve our yields, and make our people happier in their work, because compliance ensures that everyone knows what he has to do to ensure quality," says David Erdman, director of quality at DuPont Electronics based in Barleyville Plaza, Del. The company has had 15 of its 34 manufacturing sites certified, with the rest to follow by the end of this year. Not one of the certified plants has failed a vendor audit, Erdman says.

UNFORTUNATELY, relatively few U.S. companies have embraced ISO 9000. Despite the many recent seminars and conferences on the subject, the U.S. electronics industry is far behind the power curve of worldwide acceptance for ISO 9000. Tens of thousands of European companies have had their factories certified, but fewer than 400 U.S. companies can say the same, says Mark Morrow, senior editor of *Quality Systems Update* magazine in Fairfax, Va. Even worse, many U.S. companies may be unable to provide evidence of compliance—a lesser requirement that many European companies will accept in lieu of actual certification. The *Electronics Purchasing* poll shows that 42% of the respondents had no knowledge of ISO 9000 standards, and just 27% were setting up programs to comply.

With unification of Europe just around the corner, interest is reaching a crescendo, however. The best evidence is the torrent of inquiries

The ISO 9000 quality debate rages on

PRAISED by many as a good work-a-day foundation for world-class quality, ISO 9000 is seen by others as hopelessly out of step with today's quality requirements.

"I wouldn't build a good-sized doghouse based on ISO 9000," says consultant Capers Jones of Software Productivity Research in Burlington, Mass. "It would have been a good standard 10 years ago, but now it's just pablum."

The rap on ISO 9000 is many-faceted. Unlike the Malcolm Baldrige National Quality Award, the criteria deal only with production and service, leaving out marketing, engineering, and other disciplines. It does not require evidence of actual product quality, since it only ensures that policies and processes are in place to make such an outcome possible.

Many of those who have been through the process have a different take. "I was skeptical at first, but it's given us one helluva good baseline," says Joel Beck, vice president of U.S. manufacturing for Bull HN Information Systems Inc. in Billerica, Mass. By driving improved documentation and process control, ISO 9000 helps personnel understand and get involved in quality improvement. Since it is usually customer-driven, it puts quality at the forefront of the buying decision.

ISO 9000 is "a way for customers to confidently judge the quality of an organization in a world where every company now claims to be quality conscious," says Tracy O'Rourke, CEO of Varian Associates Inc. in Palo Alto, Calif. ☐

flowing into the offices of the 18 ISO 9000 registrars in the U.S. and the 1,100 or so in Europe. "U.S. companies have finally awakened to the big push in Europe," says Richard Kleckner, president of Quality Systems Registrars Inc. in Naperville, Ill. "The attitude seems to be, 'If I'm thinking about ISO 9000, why not get the actual certification and do it before the competition?' "

The problem is that time may be running out on those who want to be first on their block with an actual ISO 9000 plaque. While registrars are rushing to train additional auditors to handle the work load, sources report a one- to four-month backlog and almost all expect that to reach a year or more as the deadline looms. Companies that are not already well into the certification process, registrars say, may have trouble reaching their goal by year-end.

GIVEN THESE constraints, experts advise vendors to get close to customers to learn their requirements regarding ISO 9000 and to lay out a road map to meet their needs. Above all, don't panic, says Sarah Hagigh, an international trade specialist with the Office of European Community Affairs in the Commerce Department. The recipient of about 125 often frenzied phone calls a week from worried industrialists, she says that "everyone should stop getting so fixated on this. Get a copy of the directives to figure out if your product is regulated, try to get hold of draft directives as they come out, shop around for the best registrar, and do your homework." The EC directives can be obtained from the American National Standards Institute at (212) 302-1286.

Choosing a registrar is especially mind-numbing. Thanks to the failure of the EC nations to create a single pan-European accreditation program, there is no single registrar that can ensure ISO 9000 compliance there, let alone around the world. Until that occurs—and few expect it to happen for at least a few years—each nation will have its own accrediting agency and its own stable of registrars. Although none of these accrediting bodies recognize each other, they do allow their registrars to sub-contract auditing and even certification services to registrars in other nations.

If your company has a European subsidiary, your best approach will be to get certified by a registrar accredited by the appropriate agency in that country. In Britain, for example, the de facto choice is the British Standards Institute (BSI), which has registered more than 8,500 of the 11,000-plus ISO certificates granted to date in that country. BSI is accredited by the National Accredita-

Europe tries to get its house in order

AFTER FIVE YEARS of negotiation, the 12 nations of the European Community (EC) still can't agree on a pan-European accreditation program for ISO 9000. As a result, the authority of an ISO 9000 certificate rarely extends beyond the country in which it was granted. An ISO 9000 system throughout Europe could be five years off or more, according to Jacques MacMillan, an EC official in charge of testing and certification.

That puts U.S. companies in a bind. Without knowing who has the EC's blessing to bestow certification, U.S. companies must either risk losing market share for noncompliance or invest time and money to get a certificate that may not meet all of their customers' needs. In this country, the confusion also has stifled the formation of new registrars—for-profit ventures that assess fees primarily on the market value of their accreditation. The result? There are only about 20 registrars in the United States, versus over 1,000 in Europe, which means that U.S. ISO 9000 aspirants must find ways to break into the busy schedule of these overseas registrars—and pay the higher fees associated with cross-Atlantic consulting.

Some observers see unintended obstructionism in all the EC debate on ISO 9000. "The Europeans will, of course, deny any bad intent, but they may erect effective barriers without even intending to," says George Lofgren, president of the Registration Accreditation Board of the American Society of Quality Assurance, which many believe will be America's internationally recognized accreditation program some day. By keeping the debate internally focused, says Lofgren, the Europeans could generate policies and procedures "that would make it more difficult for U.S. companies to compete in Europe."

The Europeans are making some progress in quelling such fears, however. A European Accreditation Commission was set up in 1991 to break down differences between the various accreditation boards, and EC officials have begun talks with the Commerce Department and other U.S. bodies to share information and come up with a mutual recognition agreement. Actual negotiations have not actually begun, however, and MacMillan doubts there will be such an agreement by year's end.

Another key step was taken last June when EC vice president Martin Bangemann signed an agreement with U.S. Commerce Secretary Robert Mosbacher that named the Commerce Department's National Institute of Standards and Technology (NIST) as the body that will ultimately identify which registrars would be recognized internationally to certify ISO 9000 aspirants in the United States for each EC directive. Still, the ball remains in the EC's court. "Before we can do our part, the Europeans have to figure out what they want," says Maureen Breitenberg, a standards specialist with NIST. ☐

tion Council of Certification Bodies, which wrote the BS-5750 standard that, in large part, was adapted by the ISO to form the ISO 9000 standards. Another well-respected accrediting body is Raad vor Certificatie in the Netherlands, which is credited with designing the most widely used accreditation methodology.

For sites on U.S. soil, here are the options:

- Contract for certification with the U.S. arm of a well-established European registrar, such as Lloyd's Register Quality Assurance Ltd. in Manhattan or the National Standards Authority of Ireland in Merrimack, N.H., or with U.S. registrars who have been accredited by one of the various European accreditation bodies;
- Contract with the Underwriters Laboratory Inc. in Northbrook, Ill., which is not accredited but has an agreement with BSI and other foreign registrars to do ISO 9000 certification assessments on a sub-contract basis;
- Contract with one of three registrars accredited by the Registration Accreditation Board (RAB) of the American Society of Quality Control. RAB's first registrars are ABS Quality Evaluations in Houston, AT&T Quality Registrar in Allentown, Pa., and Quality Systems Registrars in Naperville, Ill.

While the RAB is not now recognized by the EC or any European government, it is rapidly positioning itself for acceptance once a pan-European program comes into being. In December, America's primary standards-making body, the American National Standards Institute, gave its stamp of approval to the RAB accreditation program, and RAB president George Lofgren is hopeful that negotiations with the U.S. Department of Commerce's National Institute of Standards and Technology will give the program the federal backing it would need for worldwide recognition. ☐

Additional reporting by Barbara N. Berkman in London

Who to call to get ISO 9000 certification

(partial list of accredited assessors/registrars)

Name	Number certified to date	Number under contract
ABS Quality Evaluations Houston, TX (713) 873-9400	3	20
American European Services Washington, DC (202) 337-3214	2	2
AT&T Quality Registrar Union, NJ (215) 770-3285	3	24*
Bureau Veritas Quality International Jamestown, NY (716) 484-9002	5	NA
DNV Industrial Services Inc. Houston, TX (713) 579-9003	14*	40
Intertek Services Corp. Fairfax, VA (703) 273-4124	0	60*
Lloyd's Registrar Quality Assurance Ltd. New York, NY (212) 425-8050	14	88
MET Electrical Testing Co. Baltimore, MD (301) 354-2200	14	NA
National Standards Authority of Ireland Merrimack, NH (603) 424-7070	20	25*
Quality Systems Registrars Inc. Naperville, IL (708) 778-0120	6	20*
SGS Yarsley Quality Assured Firms Hoboken, NJ (201) 792-2400	2	5
TUV Rheinland of North America Inc. Newtown, CT (203) 426-0888	0	5-6
Underwriters Laboratory Inc. **British Standards Institute** Northbrook, IL (708) 272-8800	39	200*
Vincotte USA Inc. Houston, TX (713) 465-2850	2	7

* estimated

Source: *Quality Systems Update* magazine and ELECTRONIC BUSINESS

[illegible] -A

Is top-down design for real? Yes, but it's not perfect
PAGE 44

Where microsensor markets and technology are headed
PAGE 53

Tax proposal may boost software costs
PAGE 13

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

FEBRUARY 10, 1992

What's *really* inside Japanese annual reports

PAGE 28

きていけ
したとき
ろがりまし
edium-term
nent with enough flexibility to
ckle the changes of the times, a
ened our earning power amidst
usiness conditions. As a result
managed to post increases in bo
d net income. On a consolidat
es reached ¥1,471,848 million
illion), a rise of 7.8% ov

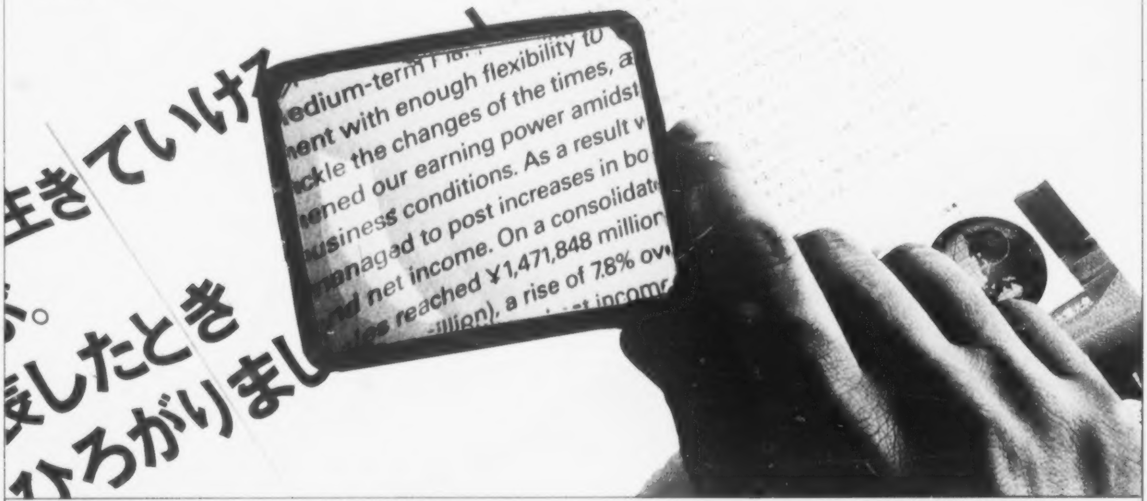
Electronic Business

VOLUME 18 NUMBER 3
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE
FEBRUARY 10, 1992

COVER STORY

28 What's buried inside Japanese annual reports?

Flexible accounting rules and misleading income data can create a distorted picture of your rival's financial fortunes


edium-term
ent with enough flexibility to
ckle the changes of the times, a
ened our earning power amidst
business conditions. As a result
managed to post increases in bo
nd net income. On a consolidat
les reached ¥1,471,848 million
illion), a rise of 7.8% ov
生きていけ
した
ひろがりまし

Cover photo by Dave Bradley

UPFRONT

Business Trends

13 Tax law alert: Software and other intangibles look out!; Intel stakes out its share of the Unix market; Can "floptical" bring vitality back to U.S. disk drives?; What's bigger than Greece but smaller than Thailand?; Teradyne's bid to crack Japan's memory test market; Water-based systems to clean up factory automation

Business Barometer

23 Leading Indicator Indicator surges way up in November

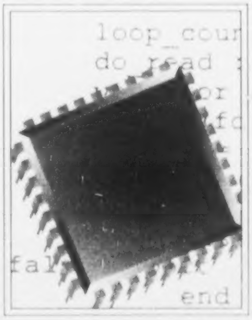
FEATURES

TECHNOLOGY REPORT

44 Make way for top-down design
Pioneers of this new approach to chip and system design report triple-digit productivity gains. Vendors may soon make the process available to everyone

53 Mini-sensors stake out mega-markets
The marriage of sensors and ICs as "micromachines" will grow the market 50%, to $2.5 billion by 1994

59 Hot air: Networks without wires
Radio frequency-based data- and voice-communication systems loom as an $11billion U.S. market by 1995, if the FCC moves fast


loop_cour
do read
fal
end

PAGE 44 Top-down technology lets engineers focus more on design functionality than on nitty-gritty details

DEPARTMENTS

Inside Business

7 How Japanese companies measure their own success

Company Index

64 Companies covered in this issue

Advertiser Index

64 Advertisers covered in this issue

My View

66 About you. And who's best at marketing

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett,
Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Reading between the lines of Japan's annual reports

THINGS ARE NOT always what they seem to be in the tricky world of corporate accounting, which poses a problem when you're trying to assess your competitors' performance. That's why ELECTRONIC BUSINESS asked veteran Tokyo correspondent Paula Doe to take our readers beyond the glossy English-language annual reports of Japanese companies for a look at how Japan's leading electronics companies measure their own success.

Contributing editor Paula Doe

While certain accounting categories appear similar in U.S. and Japanese financial reports, their meanings are far different because the fundamental concepts of organization, taxation, and ownership are so different in the two countries. This is an important lesson for U.S. electronics executives struggling to understand why, for example, an immensely successful Japanese conglomerate shows a return on investment of only 4% and why its research and development spending as a percentage of revenue looks insignificant when compared with its U.S. competitor.

Japan isn't the only economic power with financial practices that confound the U.S. executive. In a global marketplace, however, demand for standards will arise sooner or later. In a companion story, senior editor Linda Stallmann explains how 70 nation-members of the International Accounting Standards Committee are working to set guidelines for cross-border investments. One important challenge for the committee is to standardize the way R&D costs are applied to annual earnings.

If you're wondering where to put your company's R&D dollars, we've picked three especially promising technologies of the '90s: sensors, wireless voice and data communication, and—perhaps the most revolutionary in terms of its implications—top-down design. Engineers are finding that, by using advanced hardware-definition languages and simulation tools, they can focus on functionality and let the software handle the design specifications.

The complete switch over to top-down design won't come overnight: System costs must come down, functional models must be made widely available, new analog circuitry must be developed, and programming bottlenecks must be loosened. You can be sure, however, that current users' claims of 100% jumps in productivity can't—and certainly won't—be ignored. ☐

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year, $140. air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

platform viable well into the future.

It also helps lay the groundwork that Intel needs to migrate its 80x86 platforms into the inevitable prevalence of at least two non-DOS desktop system software environments. "Intel owns the DOS [hardware] market, but where is DOS going to be in two to three years when OS/2, Windows NT, and Unix take over the desktop?" says Dave Hudson of the Standish Group. "Intel wants to ensure applications on new operating systems will run on the Intel platform."

Unisys already markets DOS desktop systems built around Intel 80x86 MPUs, and the announcement appears to be a reaffirmation of past cooperation between the two companies. Under the new agreement, Unisys will build all of its hardware, right up to its largest mainframes, around Intel 80x86 MPUs. Such a strategy frees Unisys from dependence upon money-losing proprietary systems, such as its Pyramid line of computers, which often cost more and take longer to develop.

The agreement also calls for codevelopment efforts to optimize future generation 80x86 MPUs for Unisys systems that will handle Unix System V, Release 4 (SVR4) applications. SVR4 is the next Unix standard.

—David Webb in San Jose

TECHNOLOGY

Can "floptical" bring vitality back to U.S. disk drives?

A 3-YEAR-OLD San Jose start-up is hoping its technology will revitalize the floppy disk drive market—a sluggish business now dominated by Asian players.

Insite Peripherals is gearing up to deliver high volumes of a long-touted high-density 20 megabyte 3.5-inch "floptical" floppy disk drive. Encased in a standard 3.5-inch floppy disk cartridge, a floptical disk holds up to 20 Mybtes of data, 13 times the amount on standard 1.44-Mbyte floppies. The optical portion of the drive is actually a highly accurate laser servo that tells the drive where the data is. In all other respects, it is a magnetic, albeit very high density, floppy drive.

Floptical capacities could reach 160 Mbytes, says Insite's Chuck Moran

Insite has a licensed second-source manufacturer, Iomega Corp. in Roy, Utah, and has the backing of U.S. storage industry heavyweights 3M Corp. and Maxell Corp. of America, both of which will produce 20-Mbyte floptical disks that look and feel like conventional 3.5-inch floppies.

Vendors Toshiba, Teac, and Sony currently dominate the $2.3 billion worldwide floppy drive market, but they have failed to create progressively higher-capacity drives and media. The latest generation 2.88-Mbyte (formatted capacity) drive is reportedly having formatting problems and is being shunned by IBM and a slew of others. That's leaving a demand hole for 20-Mbyte and higher capacity drives from Insite and Iomega. According to Insite vice president of marketing and sales Chuck Moran, floptical technology allows for migrations to capacities reaching 160 Mbytes.

Floptical drives aren't the only 20-Mbyte capacity floppy drives currently available, however. Brier Technology Inc. in Norcross, Ga., is shipping 21.4-Mbyte (unformatted) drives using Archive Corp.'s Irwin Magnetics subsidiary as a second-source supplier. National Computer Ltd. of Japan is also licensed to manufacture Brier's drives. So far, Brier hasn't seemed to win as much industry acceptance as Insite's floptical technology.

—David Webb in San Jose

ECONOMICS

What's bigger than Greece but smaller than Thailand?

THE ANSWER IS the 34th biggest economic unit in the world: the United Republic of IBM.

The IBMs of the world increasingly are outpacing countries as growing economic units. The top 100 economies—"economy" being defined as a unit based on production, distribution, and consumption of

A sample from the "Top 100 Economies"

Rankings based on countries' 1990 GNP and companies' sales ($ billions)

33. Thailand	$64.44
35. IBM	**63.44**
36. Toyota Motor	60.44
36. Hong Kong	59.20
37. Yugoslavia	59.08
38. General Electric	**55.26**
39. Greece	53.63
40. Algeria	53.12
41. Mobil	50.98
42. Hitachi	**50.89**

Other electronics/electrical companies on the "Top 100 Economies" list

48. Matsushita Electric	$43.09
49. Samsung	35.19
64. Siemens	32.66
68. Toshiba	29.47
77. Philips	26.99
79. BASF	25.32
80. NEC	24.60
86. Bayer	23.02
93. Mitsubishi Electric	21.21
100. Daewoo	19.98

Source: The Conference Board

goods and services—include 53 nations with the U.S., Japan, and Germany at the top. It also includes 47 industrial companies. That's eight more companies on the top 100 economies list than 10 years ago.

Finland and Denmark, the 21st and 22nd largest economies, for example, are sandwiched between General Motors (20) and Ford (23). Eighteen car and oil companies number among the top 100 economies. Electronics/electrical conglomerates captured 11 top spots (see table).

—E. B. Baatz

TEST EQUIPMENT

Teradyne's bid to crack Japan's memory test market

THE EMERGENCE OF widely differing pinout configurations on high-density memory chips may help pry open the Japanese market for U.S. manufacturers of ATE. At least that's what Boston-based ATE maker Teradyne Inc. hopes.

Here's the rationale: Memory makers, now centered in Japan, are exploiting the increased capacity of 4-megabit, and soon 16-Mbit, DRAMs and other memory devices by offering a greater choice of pinout arrangements. While this should give customers more flexibility in how they use memory, existing memory testers are still designed to test one configuration at a time.

Teradyne is responding to this market fragmentation with a new tester, the J990, introduced this month, which can theoretically test up to 64 different device types at once. Rather than existing "shared-resource" ATE architectures, the J990 features a "tester-per-site" architecture—comparable to having 64 mini-testers in one box.

Japanese machines can also test 64 devices at once, but they don't offer the flexibility that will be required for the number and complexity of memory configurations coming to market, says Ed Rogas, VP and general manager of Teradyne's semiconductor test division.

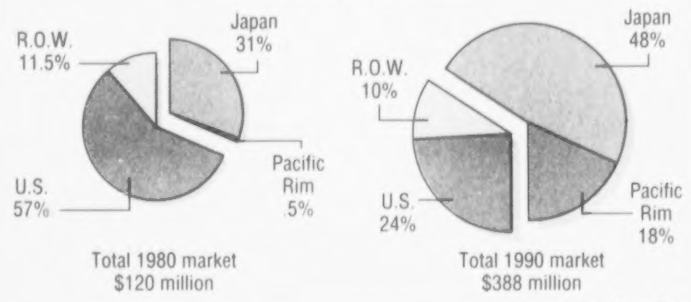
If the Teradyne approach catches on, competitors are certain to follow. That's what happened in the VLSI test marketplace, where U.S. vendors have regained the high ground with "tester-per-pin" machines that make it easier to test complex logic chips.

Like most U.S. makers of ATE, Teradyne lost out when most of the world's memory IC production shifted from the U.S. to the Far East. It has maintained a 5% share in Japan's roughly $200 million market since then, and Rogas says the company hopes to grab 30%. That won't be easy. Japanese vendors currently have 66% of the Japanese market, and their relationship with large IC makers and users remains close.

—Peter Burrows

Memory test's eastward exodus

(Memory test sales, $ millions)



Source: Prime Data

ENVIRONMENT

Water-based systems to clean up factory automation

WHEN 74 NATIONS agreed in 1990 to stop using ozone-eating chlorofluorocarbons (CFCs), the $30 million capital equipment market for CFC-based circuit board cleaning ovens evaporated faster than a puddle of freon on a summer day. On the flip side, the Montreal Protocol prompted the market for water-based cleaning ovens to start swelling.

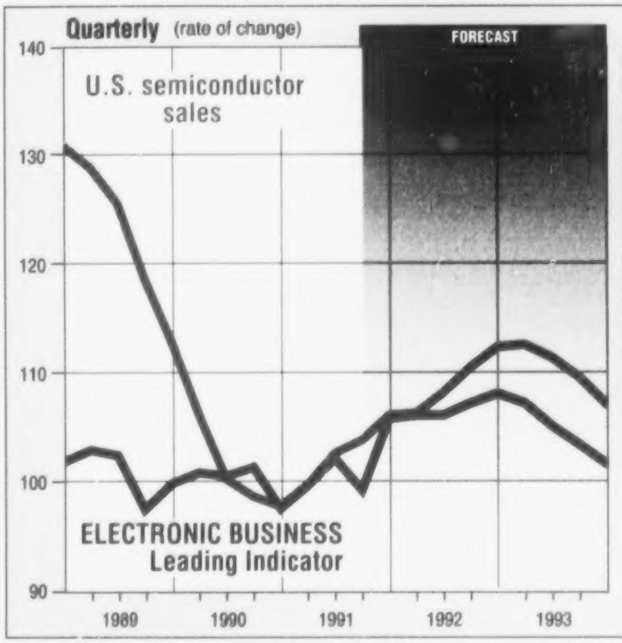
A case in point is Hollis Automation in Nashua, N.H., which has shipped more than 50 of its $25,000-to-$100,000 aqueous cleaners, making it the third-largest vendor of water-based cleaners, says Robert Schreitmueller, Hollis's marketing manager. The top two vendors are Westek in Arcadia, Calif., and Electrovert in Arlington, Tex. "It's an easy buy to justify."

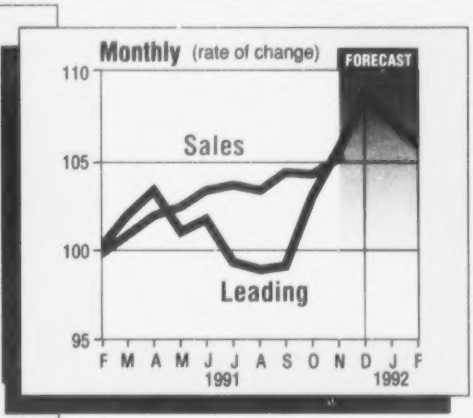
Board users' bottom lines are also benefiting. For example, Eltech Systems of Fairport Harbor, Ohio, a manufacturer of factory automation equipment, has reduced its monthly cleaning costs from $15,000 to $1,500 since it bought an aqueous cleaner from Hollis, according to Schreitmueller. Large users have even more to gain. "We have customers that were losing $50,000 to $100,000 in evaporating solvent that they never even used," says Steve Randolph, product marketing manager with Accel, another aqueous cleaner vendor in Plano, Tex.

Many observers thought that semi-aqueous cleaners—not full-aguenous cleaners—would become the new standard because their similarities to CFC-based systems often allowed them to be drop-in solutions. That changed when chemical giants DuPont and Allied-Signal announced that they were scrapping development of CFC alternatives because of their high toxicity. Also, many of the alternatives do not clean as thoroughly as CFCs do, and products are often washed in water anyway.

—Peter Burrows

ELECTRONIC BUSINESS Leading Indicator



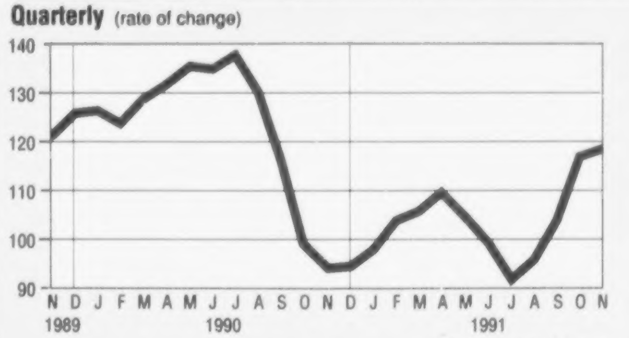


Indicator surges way up in November

THE ELECTRONIC BUSINESS Leading Indicator (EBLI) surged again in November to an unexpected high of 105.7, up from 103 in October and at its highest level in three years. Two statistics contributed the most to the boom: Buyers have reported sharply extended lead times for components, and semiconductor company stock prices have soared. A solid increase in semiconductor bookings and longer work days for production workers also confirm the trend. Components inventory and contracts for new plants and equipment are the only statistics that are not indicating a turnaround yet.

—John Farrell

Semiconductor stock prices head up in late '91



Source: Standard & Poor's

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Nov.)	105.7	103.0	97.3	99.9
U.S. semiconductor bookings ($ millions, 3-month average, Nov.)	$1,325	$1,253	$1,153	$1,254
Weekly hours of semiconductor production workers (monthly average, Oct.)	41.5	41.6	40.0	40.4
Electronic components lead time index (1977 = 100, Dec.)	87.4	88.7	67.2	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, Nov.)	64.3	63.4	54.9	64.6
Change in electronic components inventories ($ millions, SA, Oct.)	-$58	-$81	$14	$33
Contracts and orders for plant and equipment ($ billions, SA, Oct.)	$34.9	$32.9	$42.1	$38.6

SA = seasonally adjusted; all other data are not seasonally adjusted

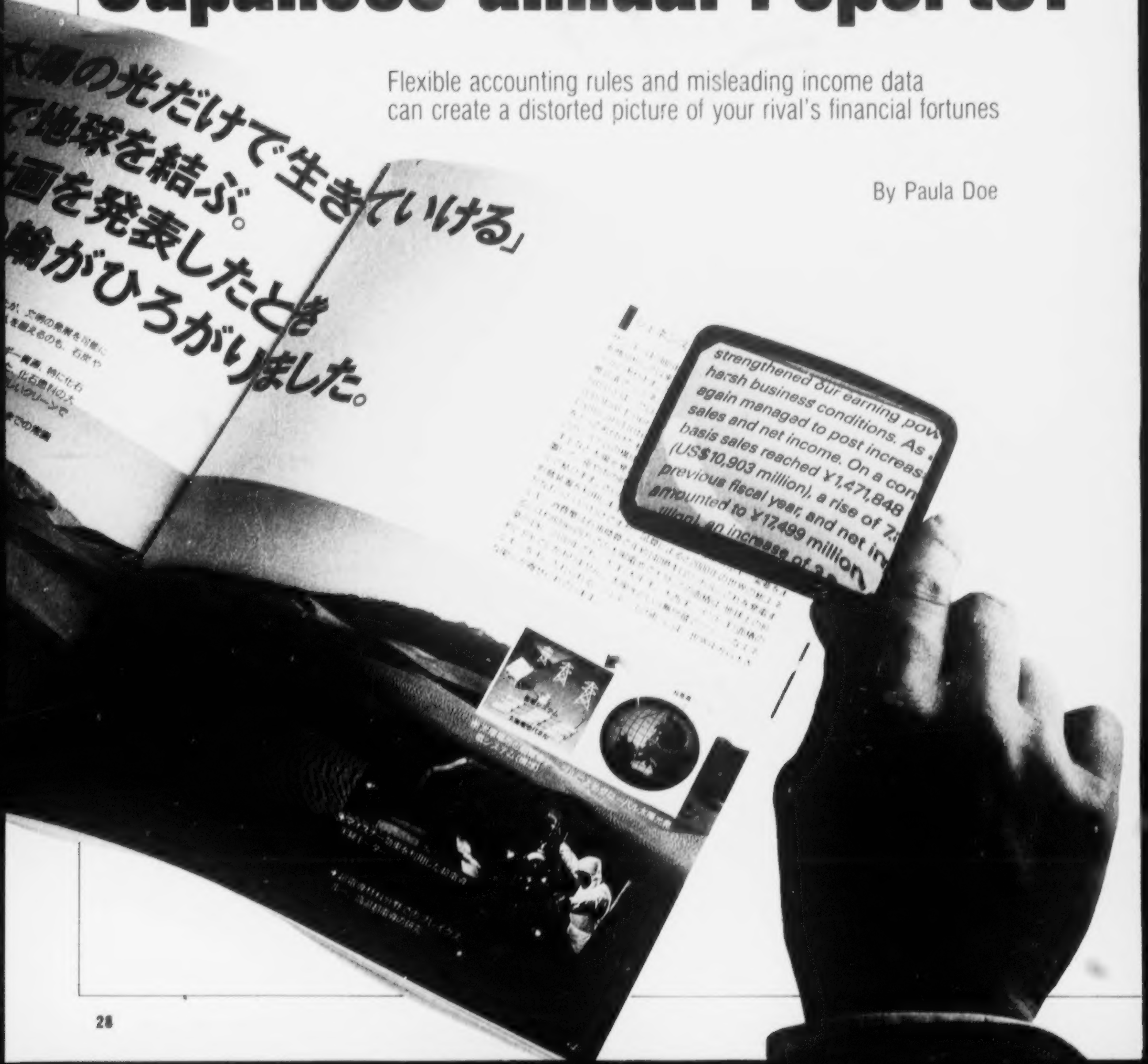
Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100

What's buried inside Japanese annual reports?

Flexible accounting rules and misleading income data can create a distorted picture of your rival's financial fortunes

By Paula Doe


陽の光だけで生きていける」
で地球を結ぶ。
画を発表したとき
輪がひろがりました。
strengthened our earning pow
harsh business conditions. As
again managed to post increas
sales and net income. On a con
basis sales reached ¥1,471,848
(US$10,903 million), a rise of 7
previous fiscal year, and net in
amounted to ¥17,499 million
illion), an increase of 3

If you've ever tried to compare your company's performance and costs with those of your Japanese competitors by looking at the English version of their financial reports, you've probably found some numbers that seem wildly out of whack with reality. Well, they probably are. Measuring your company's financial data against that of its Japanese counterpart, in fact, is a classic case of comparing apples with oranges.

The reason is that, while those glossy English-language reports from Japanese companies may look just like U.S. annual reports, the data are not put together with anything close to the same consistency as found in U.S. financial statements. Although Japanese accounting rules, themselves, differ only slightly from U.S. rules, they are applied with a mind-boggling flexibility. The best approach is to be suspicious of all numbers in the English versions.

A Japanese corporation's financial performance usually looks dismal using financial benchmarks such as profit margin or return on investment. The 10 largest Japanese electronics companies in the ELECTRONIC BUSINESS International 100 typically reported an ROI of around 4%, while the largest U.S. companies achieved a 5.9% level in 1990. But don't cry for Sony, Fujitsu, and NEC—they aren't really doing so badly.

The facts behind the Japanese figures

- Flexible rules preclude direct comparisons
- Productivity indicators exclude key subsidiaries
- Net income understated due to high tax rate
- More aggressive depreciation than in U.S.
- Entertainment and employee perks not deducted
- R&D spending somewhat inflated

Source: ELECTRONIC BUSINESS

The returns look low because of Japan's different corporate structure, aggressive depreciation schedules, high taxes, and the nature of Japanese business culture. It may sound strange at first, but the Japanese financial system doesn't demand high profits. The Japanese aversion to public confrontations, combined with the long-term interlocking stock holdings among the major companies, their suppliers, and their bankers, prevents shareholder revolt over what would appear to be poor performance. "One-third of a company's stock is apt to be held by its banks, and another third by its suppliers and customers," notes Alvin Pederson, a partner at Arthur Andersen & Co.'s office in Tokyo. "The companies cater to the stable stockholders." The system does require a return on sales of about 2% to 3% to keep the bankers off management's backs, so that's what many companies produce.

Just because the net income numbers may seem low from an ROI and margin standpoint, don't assume that profits are low. Japanese reports understate profits because of a high tax rate and rapid depreciation. "Japanese financial statements are more conservative, leaning toward understating income," explains Andersen's Pederson. Adds Richard Stolz, partner at Chuo Shinko Audit Corporation/Coopers & Lybrand in Tokyo, "Japanese statutory rates are 51.5%, and Japanese companies have lots of non-deductible expenses, so their tax rates are higher than statutory." The U.S. statutory rate is 34%. Japanese companies can't deduct entertainment expenses or employee perks—all those nights in the Ginza, golf club memberships, and executives' cars—and that adds up to a lot of yen. NEC paid about 60% of consolidated pre-tax income in taxes in the fiscal year ended March 1991, or 2% of revenues. Fujitsu paid 59%, or about 3% of revenues. In contrast, IBM's tax rate was 41%, Xerox's was 36%, and DEC's was 40%.

Large deductions for depreciation also make Japanese corporate income look low. U.S. companies use fast depreciation, which reduces earnings when calculating their taxes, but they use lower straight-line depreciation, which inflates earnings when preparing their annual reports. Japanese companies use accelerated depreciation for both. The single biggest difference between U.S. and Japanese financial reports is more aggressive depreciation, notes Steven Myers, an analyst with Jardine Fleming Securities Ltd. in Tokyo. "Japan has more liberal rules, and there is more liberal interpretation of the rules by companies."

Consider these figures: Fujitsu deducted some $1.6 billion in depreciation in the fiscal year ended March 1991, about 8% of its $21 billion sales, and more than its $1.5 billion of operating income. Overall, Japanese companies' depreciation is about 8.3% of revenue, while the top 10 U.S. electronics companies' depreciation accounted for about 6% of sales.

Much of the difference in the way U.S. and Japanese companies report financial results comes not from alternative depreciation schedules and tax rates, but from the extreme flexibility of the application of the rules in Japan.

In the U.S. there may be some minor disagreement over the definitions, but by and large, what counts as research and development—and what doesn't—is fairly clear. In Japan, it's not clear at all. Indeed, whim seems to count as much as regulations. NEC, for example, reported R&D spending of 16% of revenue for the fiscal year ended March 1990 in its English-language annual report, which has been adjusted to conform with U.S. generally accepted accounting principles. The following year, NEC reported spending only 8% of revenue on R&D, while spending 17% of sales on "R&D and engineering" combined. Why the dramatic change? It simply decided to stop including engineering work for its factories in the line item for R&D, according to company reports.

Japanese electronics profits aren't what they seem

	Top 10 Japanese companies	Top 10 U.S. companies
Profit margins (net income as % of sales)	3.1%	6.2%
Return on investment	3.8%	6.6%
Productivity (sales/employee)	$196,277	$151,675
R&D spending (% of sales)	6.2%	7.0%
Depreciation (% of sales)	8.3%	6.4%

($1=142 yen)

Source: ELECTRONIC BUSINESS

ANOTHER REASON WHY Japanese R&D spending is hard to compare with U.S. spending is the slightly different definitions of what can be included in R&D. Japanese companies can include in their R&D charges late-stage product development and even some market research expenses, which would be posted to the line items for cost-of-goods and "selling and general administrative expenses" of U.S. companies. On the other hand, Japanese companies can also capitalize new product R&D over five years, while U.S. companies expense R&D costs in the year they're incurred. Another Japanese quirk that artificially depresses R&D figures—some of the people doing R&D may come from other departments and not be charged to R&D.

The net effect of the Japanese system is probably to inflate the reported R&D spending, but not by a lot, according to analysts and auditors. It probably comes as a surprise, then, to consider that U.S. electronics companies outspend their Japanese competitors on R&D as a percentage-of-revenue measure, 7% to 6.2%, though the sheer size of Matsushita, NEC, Hitachi, Fujitsu, and the other major Japanese companies means that the absolute dollars devoted to Japanese electronics R&D dwarfs the U.S. investment (see table).

While analysts and auditors don't think Japanese companies are wildly overstating R&D spending, they advise their U.S. clients that the wide variation in R&D accounting practices makes the numbers from particular companies considerably different from what they might report if they were U.S. companies. "In Japan, there is a much smaller white area, a much smaller black area, and a whole lot more gray," explains Harold Kahn, a partner at Price Waterhouse in Tokyo. "There is much greater ability to be flexible." Also, he notes, the Japanese culture is not oriented toward junior auditors aggressively questioning senior managers at client companies.

The variability isn't a big problem in Japan, because few pay much attention to these numbers anyway. "The Japanese don't think these financial reports are very important," points out Daniel Maher, partner in Chuo/Coopers & Lybrand Consulting in Tokyo. "You should take them in the spirit in which they are prepared."

Not only do officials of Japanese companies generally ignore the stock market, they don't use complex financial information much themselves either. "Cost accounting doesn't exist," says Maher. "There are more accountants in Missouri than in all of Japan." In fact, there are only about 11,000 certified public accountants in Japan, compared with some 300,000 in the U.S. Instead of corporate accounting departments or professional accountants, most Japanese companies have small accounting groups attached to projects and staffed by generalists who rotated through accounting between assignments to, say, personnel and sales.

All of this laissez-faire approach to corporate finance is changing, though. Japanese companies are moving toward more sophisticated analysis and beginning to take an interest in the concept of measuring shareholder value, notes Kevin Jones, a principal at McKinsey & Co.'s Tokyo office. And notice how NEC's most recent financial statements conformed to U.S. standards.

Besides unusually flexible accounting, the other major problem with Japanese financial reports is figuring out just what part of the company's business is actually included.

The official report in Japan contains data for the parent company alone. Unfortunately, these are the numbers that show up in most of the electronic data bases and corporate directories from Japan, and even in a surprising number of companies' glossy English-language annual reports. Parent-only numbers are likely to leave out manufacturing plants and sales units organized as separate subsidiaries, and thus not report a significant portion of the company's costs, assets, and people.

Figures purporting to reveal the average sales per employee for Japanese companies, $196,277 in 1990, are a sham. The lack of consolidation of subsidiaries and affiliates offers top managers boundless opportunities for unreported transfers to and from subsidiaries.

Some Japanese electronics companies have consolidated reports, but these, too, have gaps. Under Japanese accounting rules, majority-owned subsidiaries don't have to be included if they comprise less than 10% of assets. Consolidated reports from Japanese companies that are based on U.S. accounting rules offer the best picture, although these reports won't provide the type of data necessary to make a clear and fair comparison: Frequently the rest of the corporate family of affiliated subcontractors remains outside these consolidated reports. By only including part of the production process on the books, Japanese costs look misleadingly low, and productivity looks misleadingly high.

"Japanese reliance upon subcontractors is much greater, so U.S. costs look higher," says Price Waterhouse's Kahn. "It's hard to tell how many similar costs are being

How the financials of top U.S. and Japanese companies compare

	Total sales ($ millions)	**Electronics sales** ($ millions)	**Net income** ($ millions)	**Net income** (% sales)	**Return on investment**	**Sales per employee**	**R&D % of sales**	**Depreciation % of sales**	**Fiscal year ended**
Japan									
Matsushita	$46,708	$33,320	$1,833	3.9%	4.2%	$221,522	5.8%	4.1%	3/91
NEC	26,179	26,179	385	1.5	2.4	221,865	7.6	6.3	3/91
Toshiba	33,232	25,048	855	2.6	4.1	205,138	6.4	5.5	3/91
Hitachi	54,759	22,853	1,629	3.0	5.0	176,782	6.3	5.8	3/91
Fujitsu	21,031	21,031	585	2.8	3.4	144,174	11.1	7.6	3/91
Sony	25,596	20,419	828	3.2	3.9	226,718	5.7	5.9	3/91
NTT	44,246	14,969	1,848	4.2	3.0	167,025	4.4	24.0	3/91
Mitsubishi	23,471	11,776	565	2.4	3.6	242,002	4.8	5.2	3/91
Canon	11,932	11,683	424	3.6	4.9	219,409	5.0	4.7	12/90
Sharp	10,847	9,000	332	3.1	3.3	296,852	5.9	5.8	3/91
United States									
IBM	$69,018	$69,018	$6,020	8.7%	9.7%	$184,631	9.5%	7.7%	12/90
AT&T	37,285	16,832	2,735	7.3	13.4	136,226	6.5	9.1	12/90
Xerox	13,583	13,583	599	4.4	3.6	137,202	6.2	5.1	12/90
Hewlett-Packard	13,233	13,233	739	5.6	8.8	143,837	10.3	4.3	10/90
Digital Equipment	12,943	12,943	74	0.6	0.9	104,375	12.5	6.2	6/90
GM Hughes	11,723	11,723	577	4.9	6.4	122,116	4.8	4.2	12/90
Motorola	10,885	10,885	499	4.6	8.3	103,667	9.3	7.3	12/90
Unisys	10,111	10,111	-437	-4.3	-6.1	134,280	7.4	5.2	12/90
General Electric	58,414	9,430	4,303	7.4	5.0	196,020	2.5	4.3	12/90
Texas Instruments	6,567	6,567	-39	-0.6	-1.3	93,390	8.2	8.2	12/90

Source: ELECTRONIC BUSINESS

International accounting standards evolving

THE DIFFERENCES among various countries' accounting standards may eventually disappear. Pressure from the international business community for truly comparable financial statements, which would encourage more cross-border investing, is expected to lead to more uniform international accounting rules by mid-decade. While major obstacles such as national corporate and tax laws are not easily hurdled, some modifications may be implemented as early as next year.

After almost 20 years of deliberations, the 70 member countries represented on the International Accounting Standards Committee (IASC) have developed 31 rules governing public securities. The IASC recently accelerated its efforts to reduce the high number of acceptable alternative approaches to accounting topics, such as the choice of LIFO or FIFO inventory valuation offered under U.S. accounting rules. The goal of the IASC is to eliminate the 30 or so topics that include acceptable alternatives. Approximately 23 of the less contentious differences are expected to be resolved by next year, leaving about six "of the tough ones to be resolved by mid-decade," says Arthur Wyatt, a senior partner with the Chicago accounting firm of Arthur Andersen & Co. and chairman of the IASC.

Several issues currently under review include subjects of special importance to the electronics industry. Resolution of different approaches to revenue recognition, accounting for the impact of changes in foreign exchange rates, and the charging of research and development activities will have a significant impact on corporate reports.

For example, the current draft on R&D proposes that development costs that meet certain specified criteria should be recognized as an *asset* and, therefore, are eligible for depreciation. Capitalizing certain development costs over a period of years instead of expensing them would come as welcome news to U.S. companies, because the shift would increase reportable earnings. Development costs that do not meet these criteria and all research costs would be recognized as expenses as incurred.

—Linda Stallmann

pushed off on the subcontractor."

Subcontractors can make companies look incredibly productive, as well. Andersen's Pederson points out how Toyota Motor Corp.'s much-touted productivity (relative to U.S. auto makers) is really largely due to subcontractors doing much of the work—Toyota does only final assembly in its own plants.

Is it impossible to develop realistic performance comparisons? Better information is available in the more detailed Japanese language reports filed annually with the Ministry of Finance. These reports are flawed—most of the details are for the parent company only—but they do have a wealth of information. Data are available on how many researchers worked at a company's various laboratories, how much the parent company charged to its administrative expenses for R&D, and how many manufacturing costs it transferred to other accounts such as R&D. ELECTRONIC BUSINESS will present a detailed report on Japanese companies based on these reports in an upcoming issue.

Help in analyzing Japanese financial statements is also coming from the authorities. Japanese securities regulators are starting to require more detailed consolidated disclosure, although they are facing fierce resistance. In addition, an international movement to develop more uniform accounting rules is under way. Accounting firms and electronics companies will be revising their definitions of R&D, depreciation, and other financial items to more closely conform with international standards during this decade. While Japanese companies may not be the first to embrace international standards in the short term, the need to attract international investors ultimately will encourage a more consistent approach. □

Paula Doe is ELECTRONIC BUSINESS's Tokyo correspondent and has been writing about the electronics industry's financials for eight years

Additional research by Linda Stallmann

A detailed analysis of Japanese electronics companies' hidden financial data will be published in an upcoming issue of ELECTRONIC BUSINESS

TECHNOLOGY

Hot air: networks without wires

Radio frequency-based data- and voice-communication systems loom as an $11 billion U.S. market by 1995, if the FCC moves fast

By David Webb

Last year, Apple Computer Inc. in Cupertino, Calif., petitioned the Federal Communications Commission (FCC) to allocate a certain band of radio frequency for use in wireless data communications systems. Beyond stirring a few ripples in the trade press and jokes ("I want my AppleTV"), the petition's real ramifications were largely misunderstood.

Actually Apple, Oracle, Motorola, National Semiconductor, and even IBM are paving the way for one of the next important technology waves of the electronics industry: wireless data and voice communications. These companies are actively developing systems to broadcast data inside buildings and on campuses, throughout cities, and across continents by leveraging public airwaves, private and public satellite networks, and existing terrestrial cellular and microwave networks. "There is a fundamental need for both portability and ease of communications in the computer market right now," declares Gary Johnson, National Semiconductor's director of marketing and operations for its mobile communications products.

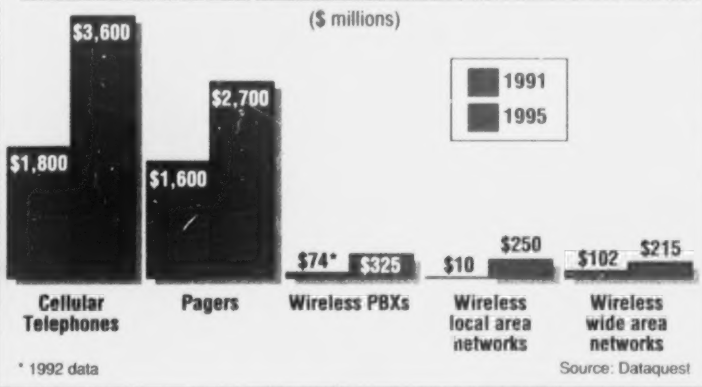
The U.S. personal and wireless communications markets will reach $11 billion in service and hardware revenues by 1995, according to Dataquest Inc. in San Jose. Add to that the European markets, perceived to be well ahead of the U.S. in frequency allocations and wide-area personal communications products, and the Asian market, which sports the highest per-capita use of cellular systems in the world, and the total worldwide wireless communications market could easily be four times the size of the U.S. market by 1995. "For a lot of people, wireless means cellular," says Stephen Hester, president of SDH & Associates, a Sunnyvale, Calif., communications research firm, "but if you start looking at the full spectrum of wireless, it turns into some potentially huge market opportunities."

Significant regulatory and market challenges currently hinder the U.S. market from realizing its potential. The FCC has to allocate precious radio spectrum and the industry has not yet agreed to protocols and other technological standards. Vendors have been able to enter some of the markets by buying spectrum access from current licensees.

Last year, vendors began to enter the wireless local-area network (LAN) market. Motorola shipped the hardware and boards for its Altair wireless LAN product line and is considered one of the leaders in the fledgling market. "This is a strategic element of Motorola's future strategy," claims Hester. Dataquest predicts that the wireless LAN market will grow in the U.S. from $10 million in 1991 to $250 million by 1995. NCR, Photonics, and BICC Communications are other early entrants shipping radio-frequency or infrared wireless LANs.

Another new form of wireless LAN actually is a misnomer—it depends on the existing electrical wiring in buildings in combination with infrared data exchangers. Small

The booming market for wireless communications gear



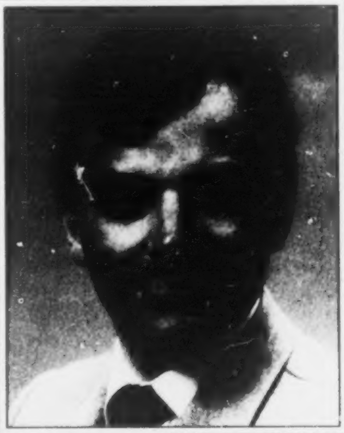
* 1992 data

Source: Dataquest

businesses with limited funds and data-transmission rates are the primary market for the "carrier current"-based systems—110-volt wires as the transmission medium. Using existing electric wiring offers small LAN users the convenience of wireless LAN systems—it's easy to move the PCs as their companies grow and need to move into larger spaces.

Local-area networks using cables won't be threatened with obsolescence until wireless system performance eclipses the performance of wire-based systems. It will be well after the year 2000 before cables are truly passe, due to users' need to leverage their investments in wire hardware. By mid-decade, however, users will have the option of installing wireless LANs that are competitive on a cost-of-ownership basis relative to wire-based systems.

At the wide-area network (WAN) level, Motorola and IBM created a nationwide radio-frequency data communications service called Ardis four years ago. It's a packet radio data information service with access limited to 400 U.S. metropolitan areas. Last year, Motorola announced its plan for Iridium, a 77-satellite radio network that would span the globe by 1996. In New York, Ram Mobile Systems Inc. predicts a mid-1993 launch for its wireless data communications network similar to Ardis. Two Washington, D.C., companies, Mobile Telesystems Inc. and Metropolitan Fiber Systems Inc., are building satellite packet radio systems similar to Ardis to offer WAN service, replete with their own computers. Dataquest estimates that that market will grow from $102 million in 1991 to $215 million by 1995.



Silicon will be 40% to 50% of the hardware cost of wireless personal communications systems, notes Gary Johnson, director of marketing and operations for National Semiconductor's mobile communications group

Many other wireless markets are under development. Vendors are working on in-building wireless telephone switchboards (PBXs). IBM, Hewlett-Packard, Poqet Computer, and others offer notebook and handheld PCs that communicate via radio frequencies and infrared signals. "Within five or six years, nearly every notebook and handheld PC will have some sort of wireless communications capability," says Ake Persson, executive vice president of business development at Ram Mobile Systems.

A wireless communications market for consumer products also tantalizes vendors. Personal communications networks (PCNs) would eventually eliminate conventional pay telephones, replaced by miniature cellular telephones that fit in a pocket. Dataquest estimates the U.S. PCN hardware market to grow to $5.4 billion by the end of the decade, with $6 billion in U.S. PCN service revenues. Chip vendors are especially interested in this market because of the high volumes of high value-added products. "Silicon will be 40% to 50% of the hardware cost," notes National's Johnson, "and is now driving PCNs to market."

The FCC has been slow to react to spectrum applications, much less approve them

A variety of technologies are being used in these pioneering wireless applications. Motorola's Altair system uses an 18-gigahertz narrowband frequency for data interchange between computers within a building. NCR's WaveLAN product and Telesystems' Arlan wireless network use "spread-spectrum" radio frequency transmissions, which essentially spread data over simultaneously broadcast frequencies in a coded form known only to the system's transceivers and receivers. Other wireless LAN vendors such as BICC and Photonics avoid FCC hassles by adopting infrared LAN systems available without a license.

Access to the radio spectrum for true wireless networks is tied up in a regulatory morass. The FCC has been slow to react to spectrum applications, much less approve them, since the required airwaves have already been allocated to other licensees. Lobbying from incumbents who don't want to share or relinquish their previously allotted part of the spectrum has delayed new allocations. "There's absolutely no spectrum shortage," insists Edgar Sack, chairman of Zilog Inc., a Campbell, Calif., chip maker that is closely watching the wireless market, "just poor utilization of the spectrum."

In addition, vendors, regulators, and users have to agree to technological standards that must precede development of the broadcast infrastructure required for WANs and PCNs. European regulators and vendors already have a two-year advantage in setting up their wireless standards.

However, the FCC is making progress. In early December, the commission began to consider a bandwidth allocation in the 1.8- to 2.3-GHz frequency range of the public radio spectrum for wireless networks. Vendors expect that a band somewhere within that spectrum will be approved and allocated for PCN and data communication applications. "By mid-year, the FCC will give systems manufacturers enough guidance to get them started," predicts National's Johnson. ☐

CFC alternative is free for the asking
PAGE 13

Single-board computers sing commodity blues
PAGE 50

Capital spending to rise slightly in '92
PAGE 13

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE
FEBRUARY 24, 1992

INTELLECTUAL
PROPERTY
REPORT

PROTECTING THE POWER OF THE IDEA

PAGE 24

Electronic Business

VOLUME 18 NUMBER 4

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE

FEBRUARY 24 1992

COVER STORY

24 Protecting the power of the idea

As the industry moves from the age of manufacturing to the age of intellectual property, companies remain dangerously exposed to rip-offs. Are your assets covered?

38 Patent protection around the world

Why is a Japanese patent different from a U.S. patent? Can a single patent protect you in 15 European nations? Here's an intellectual-property guide for the non-expert

FEATURES

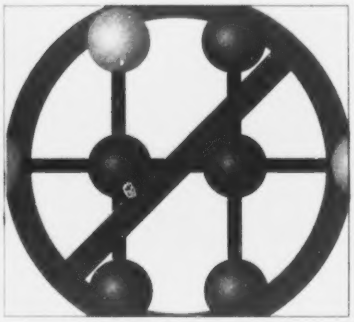
50 Turmoil at the single-board carnival

Board vendors caught by the collapse of personal computer prices are touting their latest attractions—RISC chips, software, and services

UPFRONT

Business Trends

13 Electronics will benefit from expected hike in capital spending; Looking for a CFC-buster? Call Northern Telecom; Germany is a bright spot in the murky ATE market



PAGE 13 Chlorofluorocarbon buster

DEPARTMENTS

Inside Business

7 Protecting your company's biggest assets: Its ideas

Company Index

56 Companies covered in this issue

Advertiser Index

56 Advertisers covered in this issue

Viewpoint

58 Enough name calling! How about some sticks and stones

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Protecting your company's biggest assets: Its ideas

Senior editor Rick Whiting

When Ralph Waldo Emerson observed that the world would beat a path to the door of the innovative mousetrap inventor, he was talking about a horde of grateful customers. In today's global electronics marketplace, his dictum applies equally to the mob of competitors rushing to cash in on a good thing. Innovative ideas are among a company's most precious asset—for U.S. companies, say some, the last defensible asset. How to protect this priceless intellectual property is the subject of this issue's cover story.

From top legal and business experts, senior editor Rick Whiting has compiled a list of critical how-to's and several case histories of companies that acted effectively to identify and protect their most important ideas before entering the market. An essential step, say experts, is to understand the strengths of patent, copyright, and trade-secret protection.

Innovation is notoriously indifferent to national boundaries, so U.S. electronics executives have to think globally. To help them, contributing editor Paula Doe in Tokyo and senior editor Barbara Berkman in London examine the ways intellectual-property issues are treated abroad. It's important to know, for example, that Japan is working to strengthen its intellectual-property system, extending patent coverage for software and instituting a new trade-secrets law this year. In Europe, U.S. companies have to move carefully because of the expense of filing for patents and the strict disclosure requirements.

There is widespread concern about the "dark side" of intellectual-property protection: the time and money spent in court instead of in the design laboratory. But there is a bright side as well: Protecting their best ideas forces companies to acknowledge their market value and even to promote innovation. Recognizing that their most valuable assets "walk out to the parking lot every night," many leading companies give bonuses to engineers whose ideas are innovative enough to win patents.

Other companies, however, find reasons to deliberately serve up their ideas to the competition. Case in point: Northern Telecom, which reckons to save $50 million by the year 2000 with its non-CFC cleaning process. Contributing editor Dwight Davis reports that NT is sharing the technology with anyone at no cost. Now that's a notion a practical humanist like Emerson would really appreciate. ☐

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA. Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140 air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

BPA ABP

CAPITAL SPENDING

Electronics will benefit from expected hike in capital spending

LET'S FACE IT, the recession is putting big restraints on the industry's capital spending. Despite the gloomy economy, however, 42% of electronics CFOs expect to increase their spending in 1992, while only 16% expect to decrease spending. The future looks even better in the long term, based on the five-year spending plans for the 120 electronics companies surveyed last winter by ELECTRONIC BUSINESS.

The 1992 CFO outlook for capital spending

Change in spending (% of CFOs)		Capital spending % of revenue (avg.)
1991 vs. 1990		**1991**
Increase	48%	
Decrease	44	8.1%
Same	28	
1992 vs. 1991		**1992**
Increase	42%	
Decrease	16	8.2%
Same	42	
1996 vs. 1991		**1996**
Increase	79%	
Decrease	4	6.9%
Same	17	

Source: ELECTRONIC BUSINESS

For makers of electronic equipment and computers, the CFO survey provides some unexpected good news. Nine of every 10 CFOs report they'll buy factory capital equipment this year, spending 44% of their budget on such equipment. Nearly nine of 10 CFOs will spend money on office computers; and eight of 10 will approve the purchase of R&D and lab equipment. So *whatever* capital spending pick-up the economy sees this year, electronics companies will be the prime beneficiaries.

Hard numbers aside, personal interviews with electronics CFOs show pessimism continues. "Everyone is pulling back and all our big customers have a wait-and-see attitude now," says Randy Reed, CFO of Microfield Graphics Inc. in Beaverton, Ore. As a result, says Reed, the small designer and manufacturer of graphic controller boards is leveling off its own spending plan this year. In fact, 42% of CFOs surveyed say their 1992 spending plans will remain unchanged from last year's levels.

What they're buying

	% of CFOs	Share of budget (avg.)
Buildings	47%	13%
Office computers	86	16
Other office equip.	64	8
R&D/lab equip.	77	28
Factory capital equip.	89	44
Environmental capital equip.	37	7

Source: ELECTRONIC BUSINESS

According to ELECTRONIC BUSINESS's exclusive semi-annual CFO survey, 17% of companies indicate improving quality is their primary reason for making capital investments this year. Cole Pardue, vice president of finance for Tennelec/Nucleus Inc. agrees with Reed. "We're only buying equipment we feel we need right now in order to improve quality and keep us competitive," says Pardue, so vendors of electronic equipment with the potential to raise productivity, lower costs, and improve quality will continue to be winners this year.

A quarter of the finance execs surveyed blame the poor availability of credit for their capital woes, although small companies were more likely to gripe about credit problems. Even the CFOs who didn't blame the banks indicated that the terms of their bank loans had worsened over the past year.

Despite the mixed outlook for 1992, the finance officers' long-term capital spending plans are overwhelmingly optimistic. Eighty percent of the CFOs believe their spending will be higher in 1996 compared with 1991. Of course, for many companies, spending has nowhere to go but up and their rosy outlook is directly tied to their optimism about their companies' revenue and profit projections. Companies in the survey spent an average of 8% of their revenue on capital equipment in 1991. By 1996, CFOs expect to reduce that ratio to 6.9%. Viewed this way, the long-term outlook does not bode well for U.S. competitiveness.

Why they're buying

	% of CFOs
New product introductions	33%
Adding capacity	26
Reducing costs	17
Improve quality	17
Other reasons	7

Source: ELECTRONIC BUSINESS

Of course, any five-year forecast must be taken with a grain of salt. As CFO Reed says, "You have to be a fortune teller to predict capital spending five years out."

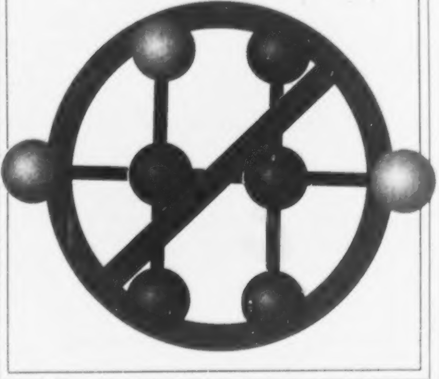
—*E. B. Baatz*

TECHNOLOGY

Looking for a CFC-buster? Call Northern Telecom

IF YOU'RE STILL searching for ways to reduce your dependence on CFCs used in manufacturing operations, Northern Telecom wants to help you. NT claims its CFC-elimination technology will save it $50 million at the end of the decade, and says it has made its technology freely

Chlorofluorocarbons-buster



available to the industry.

NT's "no clean" process eliminates the cleaning phase of printed circuit board (PCB) manufacturing. CFC solvents usually remove flux, which is applied to the boards to aid in the soldering process. NT devised a spray-misting technology that coats boards with a flux mixture of just 2% solids and 98% alcohol. The soldering process boils off the alcohol-based flux, so no cleaning stage is required.

This approach, which NT has implemented in its 42 worldwide manufacturing plants, negates the need to buy and maintain cleaning equipment, purchase CFC solvents or alternatives, dispose of waste solvents, and pay higher, CFC-related taxes. "From 1988 to 1991, the program cost us about $1 million and saved us $4 million," estimates Art FitzGerald, NT assistant VP for environmental affairs. By weaning itself from CFCs nine years ahead of the year 2000, the deadline set by the Montreal Protocol, the Canadian communications equipment manufacturer should save more than $50 million and prevent the atmospheric release of almost 9,000 tons of the solvents.

The biggest roadblock to widespread industry use of the no-clean technique isn't industry willingness, but U.S. military requirements, FitzGerald says. Nine CFC-alternative solvents have been approved for military-destined products, but the no-clean, no solvent approach is still under review. As a result, even commercial suppliers that do *any* business with the military can't yet deploy the NT method.

Even the use of the nine CFC alternatives is inhibited, says Dave Bergman, director of technology programs for the PCB industry association, the Institute for Interconnecting and Packaging Electronic Circuits. The alternatives don't have blanket approval for use with pre-existing military contracts, only future ones. To switch earlier programs from CFCs to more benign methods, electronics contractors will have to spend millions of dollars negotiating with the military on a case-by-case basis, Bergman complains.

For more information, call NT's FitzGerald at (416) 566-3048.

—Dwight Davis in Seattle

INTERNATIONAL

Germany is a bright spot in the murky ATE market

DESPITE forecasts of continued sluggishness in automated test equipment (ATE), U.S. board and chip test equipment makers could have some luck selling into Europe.

In board test, Germany is Europe's biggest market. Sales to Germany in 1992 will amount to between $67 million and $73 million, vendors estimate. About half that business is in combinational test, with the rest in manufacturing-defect analysis and low-cost in-circuit test. However, because many European businesses downsized in 1991 and put their used ATE on the block, there remains a substantial gray market for ATE in Europe. GenRad estimates that in Germany alone, used ATE will account for up to $4.6 million of 1992 sales.

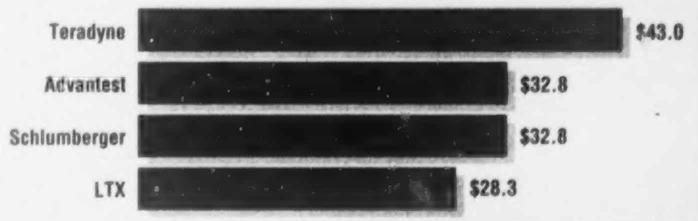
Hewlett-Packard anticipates sales of its high-end IC tester will pick up in telecom test for GSM mobile phone equipment. European IC test market leader Teradyne predicts European sales will rise in 1992 because of pent-up demand. It reports early signs of improvement: Teradyne sold its first $1.2 million VLSI test system in Europe in late 1991 to IBM in Germany.

If customer reaction is any indication, however, user interface software will be the hot item of 1992 in Europe. Siemens AG reports it ordered Westwood, Mass.-based LTX Corp. testers recently, largely because it liked the user interface. Schlumberger's user interface is "very impressive," reports Reinhard Balasus, manager of test for Fuba Communication, a $330 million German company. Such fancy software doesn't come cheap, though, and Europeans might make do in 1992 with less costly alternatives.

—Barbara N. Berkman in London

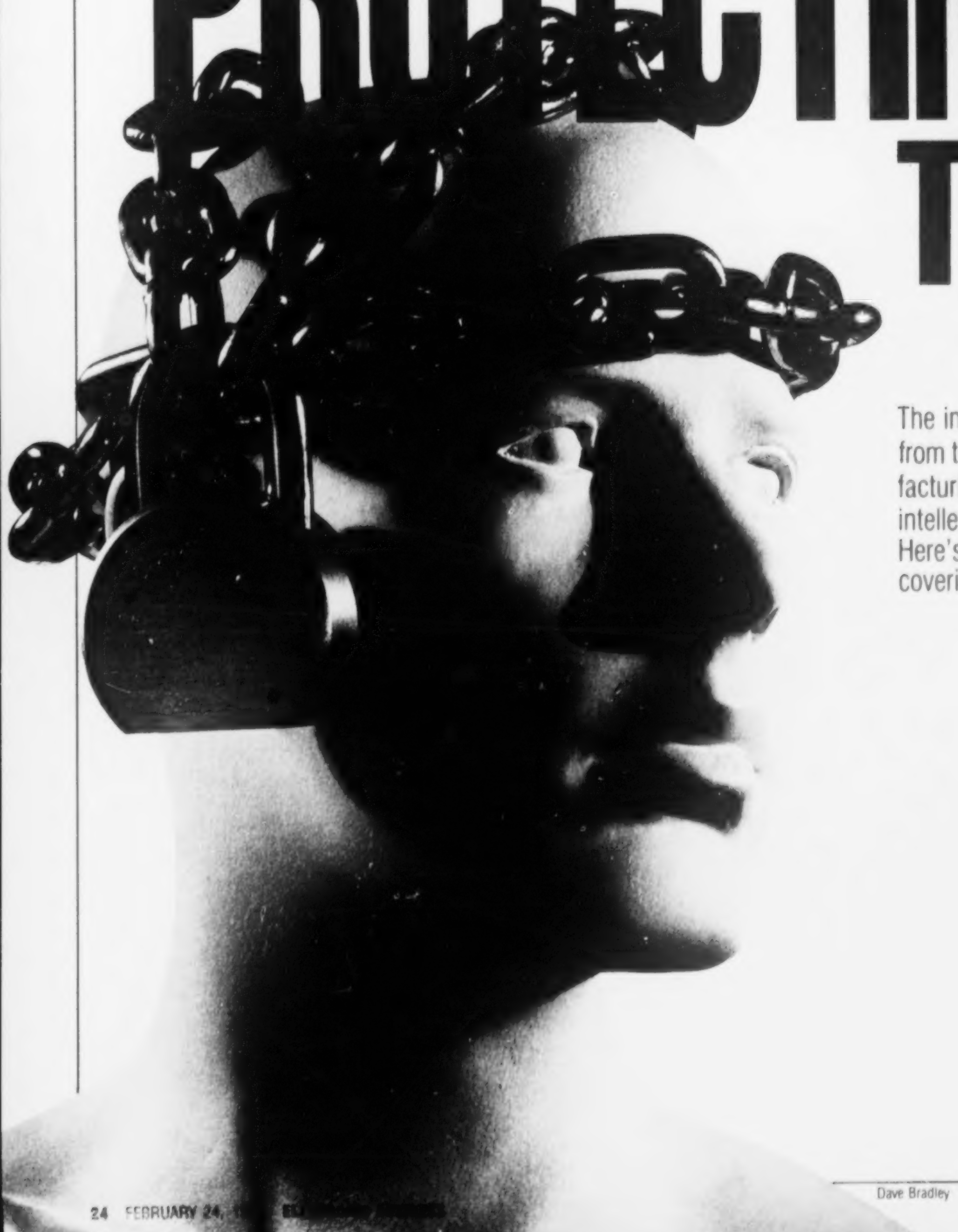
Top IC test vendors in Europe

(1991 sales, $ millions)



Source: VLSI Research Inc.

PROTECTING THE



Dave Bradley

The industry is moving from the age of manufacturing to the age of intellectual property. Here's a guide for covering your assets

POWER OF THE IDEA

By Rick Whiting

DURING THE PAST few years, average gross margins at U.S. pharmaceutical companies have run 70% or higher, nearly twice the rate for semiconductor companies. Why the difference? The drug industry does a better job of protecting its intellectual property.

If profits alone isn't reason enough to protect your intellectual property, the increasingly hostile legal environment should be: While the number of patents issued in the U.S. grew by 46% between 1980 and 1990, the number of patent-related lawsuits increased by more than 50% during the same period, according to the U.S. Patent and Trade Office. "We're moving from a manufacturing era to an intellectual-property era," says Ron Collett, an attorney and Dataquest analyst.

Still, only a relative handful of U.S. electronics companies—led by Texas Instruments, Hewlett-Packard, and Mentor Graphics—have adopted systems for identifying, defending, and wringing the most from their intellectual property. In general, the systems boil down to a few key strategies:

- Routinely identify technologies that require protection. That means designating a patent liaison officer to oversee the process and creating a patent committee to screen potentially important intellectual property;
- Protect intellectual property with patents, copyrights, or other formal means, or designate critical expertise as trade secrets;
- Educate engineers and other employees on the importance of intellectual property. Provide incentives to encourage engineers to flag their innovations for protection;
- Build a patent portfolio that can be used to protect against infringements on intellectual property, as a defense against lawsuits from other companies, and for bargaining power in cross-licensing deals.

SEVERAL COMPANIES have established patent committees, often made up of attorneys and engineers, that periodically review the company's technology, products, and designs. At HP, the first step is to annually survey company managers about strategic emerging technologies for the company and the industry. Using the survey results as a benchmark, engineering managers designated as "patent coordinators" review the latest innovations within their departments and smoke out what should be protected.

One problem facing such companies is teaching engineers about the subject. "Many engineers think that it has to be a splash of genius to be patentable," says Jerry W. Mills, an attorney with the Baker & Botts law firm in Dallas and chairman of the firm's Intellectual

Property Group. Even incremental improvements often merit patent protection, he says. Adds Frank S. Delia, vice president and chief legal and administrative officer at Mentor Graphics, "We make sure engineers look early in the development cycle to see if we have some [innovation] worth patenting."

Rick Rappaport/Black Star

Mentor Graphics pushes its engineers to look hard for patentable innovations, says vice president Frank S. Delia

To encourage engineers to identify ideas and technology that might be worth protecting, Advanced Micro Devices Inc. (AMD) awards bonuses to engineers of $1,500 or more for successful patent applications. HP's Stephen Fox, associate general counsel and intellectual property director, advises engineers: "When in doubt, report it."

One example of how easily intellectual property can be overlooked occurred at John Fluke Manufacturing Co. in 1981. In a casual conversation with a Fluke engineer, then-corporate attorney Mikio Ishimaru learned of a digital multimeter the company had been selling for 11 months. The engineer had devised an analog-to-digital converter chip for the product that simultaneously handled fast and slow signals, a feat the engineer considered routine. Ishimaru, now director of technology law and associate general counsel at AMD, moved quickly to patent the device. When a Japanese company began marketing a copy of the multimeter a year later, Fluke mounted a successful court challenge.

Intellectual-property protection can also be stymied by the industry's rapid technology cycle and short product lifespans. Why patent an invention, some ask, when the product will be outdated in 18 months—long before a patent can be awarded?

Anyone who believes that the rapid technology cycle precludes the need to protect intellectual property "has their heads in the sand," says Jerry Rogers, president and CEO of Cyrix Corp. in Richardson, Tex. Companies that fail to protect their core technologies all but encourage competitors to build follow-on products without copying the original. And if the competitors patent *those* products, a company could be locked out of a market it pioneered.

Japanese companies capture the top spots

U.S. patents issued in electronics and instrumentation in 1991

1. **Toshiba**	895
2. **Hitachi**	869
3. **Mitsubishi**	793
4. **Motorola**	572
5. **IBM**	563

Source: MicroPatent

AMD, in fact, found itself in just such a fix because of a lawsuit brought by Brooktree Corp., a San Diego designer of graphics and imaging chips. At the time that AMD invented a bipolar "color palette" chip in the early 1980s, says Ishimaru, the company was using patents to cover broad technology areas rather than specific semiconductors. Brooktree later developed, and patented, a CMOS color palette chip. When AMD came out with a CMOS implementation of its chip, Brooktree sued for infringement and won a $25 million judgment against AMD in 1990. The case remains on appeal.

ELECTRONICS companies face another special intellectual-property problem: Most company secrets are carried around in the heads of employees. The relatively high rate of job-hopping within the industry exacerbates the problem. Attorney Tim Covington of Palo Alto's Wilson, Sonsini, Goodrich, Rosati recommends that new employees be made to sign confidentiality agreements in which they promise not to disclose trade secrets *and* not to obtain other companies' trade secrets, the latter for use in the event the company is charged with illegally obtaining insider information.

Seagate Technology is learning a painful lesson in such a case. IBM sued Seagate last October because the disk drive company hired away the manager of IBM's magnetoresistive (MR) head design program. The suit charges that the manager was hired to help Seagate create products using the MR technology that IBM considers a trade secret. Last month a federal judge slapped Seagate with a preliminary injunc-

U.S. and Japan aggressively protect their chip designs

Registrations under Semiconductor Chip Protection Act of 1984

	1985-87	1988	1989	1990	Total
U.S.	1,920	530	530	309	3,289
Japan	1,151	453	585	759	2,948
Other countries	173	64	47	25	309
Total	3,244	1,047	1,162	1,093	6,546

Source: U.S. Copyright Office

tion prohibiting the company from using or disclosing the MR technology pending trial. In such situations, patents are one of "the best ways to make sure the technology stays with the company," says attorney Mills.

Similarly, a thick patent portfolio is the best means of protecting a company against infringement charges. "Intellectual property as a defensive weapon is extremely high on our list of priorities," says Cyrix's Rogers. Cyrix and its math co-processor chip have been the target of patent infringement lawsuits brought by Intel Corp.

The bitter patent dispute between Motorola Inc. and Hitachi Ltd. in 1990 is a case in point. Motorola had charged that Hitachi's H8 and H16 microprocessors violated patents held by the U.S. company. But Motorola received a shock when Hitachi countersued, claiming that Motorola's cash-cow 68030 microprocessor violated one of its patents. Hitachi's patent, which

Weapons for the intellectual-property wars

DECIDING HOW to protect intellectual property—whether via patents, copyrights, trade secrets, mask-work rights, or trademarks—can be as important as deciding what to protect. Determining which is best "can be a fundamental decision for a company," says Tim Covington, an attorney with the high-tech law firm Wilson, Sonsini, Goodrich, Rosati in Palo Alto, Calif.

Patents, the strongest form of legal protection, grant an exclusive monopoly for 17 years by protecting ideas, designs, and inventions against copying and infringement—even if done unwittingly. The U.S. Patent and Trademark Office grants patents on the basis of three criteria: Is the invention or design new or novel? Is it useful? Is it "non-obvious to a person of ordinary skill in the art?"

A major change in the federal court system 10 years ago offers reason enough to seek patent protection. Before then, patent lawsuits were tried in federal district courts and as many as 70% of all patent challenges were successful. But in 1982, Congress created the U.S. Court of Appeals for the Federal Circuit in Washington, D.C., specifically to hear patent cases. Today the numbers are reversed—patents are upheld in two out of three cases.

Copyrights are narrower in scope than patents and guard only against someone copying specific material, not the ideas it contains. Although they can be recorded with the U.S. Copyright Office in Washington, copyrights apply automatically to any original work "as soon as you put down your pen or shut off your computer," says a copyright office spokesman.

Trade secrets have the advantage of having no time limit. (Patents expire after 17 years.) One example is Coca-Cola's decision to keep its syrup formula a trade secret rather than patent it. Had Coke patented its recipe years ago, it would no longer be a secret. Although trade secrets are not legally protected, lawsuits alleging trade-secret infringement can succeed if a judge or jury is convinced that the intellectual-property owner took every step possible to guard against disclosure.

Another weapon available to chip makers is the Semiconductor Chip Protection Act of 1984, which protects a semiconductor's design or mask work for up to 10 years. Mask work is eligible for protection when it becomes fixed in a semiconductor and is registered with the U.S. Copyright Office or "is commercially exploited." Although the law was passed to prevent foreign companies from copying chips made by U.S. companies, the Brooktree/Advanced Micro Devices suit is so far the only case brought to trial under the statute. □

covered access methodology to on-chip memory, allowed the Japanese company to launch a counter-offensive. The issue was settled out of court when a federal court judge threatened to halt sales of chips by both companies.

Such thinking, for better or worse, is creating a patent arms race within the industry, says a chip company executive who requests anonymity. "Everyone is building up their patent portfolios, like the U.S. and the Soviet Union did with missiles during the Cold War."

As a way of avoiding costly lawsuits, some companies are turning to cross-licensing, in which they make their intellectual property available to each other. Covington says the technique works best between companies that

Software: Intellectual property's new frontier

SOFTWARE DEVELOPERS generally lag other segments of the electronics industry in establishing programs to protect their intellectual property. "Software companies are going to have to start paying attention," warns Jerry W. Mills, an attorney with the Baker & Botts law firm in Dallas.

Not every company has been lax. In a corporate memo leaked to the press last May, Microsoft Corp. chairman Bill Gates expressed amazement at his company's failure to take advantage of the patent system. He exhorted his managers to "patent as much as we can" and explore patent cross-licensing deals with other large companies.

The generally low level of awareness is surprising given the ease with which software can be copied when compared with the equipment and expertise needed to knock off, say, a semiconductor. "We are the most exposed industry in the world," says Ken Wasch, director of the Software Publishers Association in Washington, D.C., which has been vigorously fighting software piracy.

Part of the problem is cultural. Software developers are free spirits, artists who often view patents as restrictions on their creativity. And keeping intellectual property in-house is particularly difficult in the software industry because programmers change jobs frequently and, deep down, consider their work to belong to them rather than to their employer.

Adding to the problem has been the murky question of just how intellectual-property protection laws apply to software. It was not until 1980 that U.S. copyright law was amended to specifically include software, although the U.S. Copyright Office has accepted copyright registration for software since 1964.

While software companies in the past relied on copyrights for protection, more and more now seek patent protection as well. A copyright covers the code or instructions for a pull-down menu, for example, while a patent protects the concept of a pull-down menu itself.

Copyrights make illegal the kind of outright copying practiced by software pirates. But just as engineers have become adept at reverse-engineering semiconductors, developers are becoming more experienced at reverse-engineering software code and writing their own software that performs the same tasks without infringing copyrights, according to Tim Covington, an attorney with the law firm Wilson, Sonsini, Goodrich, Rosati in Palo Alto, Calif. He suggests that developers protect their software with both a copyright *and* either a patent or trade secret.

In addition to relying on copyrights to protect the source and object code underlying its products, Mentor Graphics considers its code to be a trade secret and contractually binds customers who are given access to the code to keep it confidential.

Several events this year are expected to help clarify just where software stands concerning intellectual-property protection laws. Imminent is a report from the Office of Technology Assessment that will explore the issue of whether the "look and feel" of computer software can be protected under existing laws. A Special Advisory Commission on Patent Law Reform is expected to propose new rules for software protection in a report due in August. Observers add that the pending Apple Computer Inc. lawsuit, charging Microsoft Corp. and Hewlett-Packard Co. with infringing its Macintosh graphical user interface, will go a long way toward determining how broadly intellectual-property laws can be applied to computer programs. ☐

have complementary technologies but sell into different market niches. Mentor's Delia, for example, tells of a suit brought against the company by competitor Valid Logic Systems Inc. in 1985. Each held a patent for a hardware modeler suite of software and Valid claimed Mentor was infringing its patent. Delia says there were slight differences in the two patents and the two companies resolved the dispute by cross-licensing their technologies.

That, of course, fuels the argument for patenting as much technology as possible. "Having a substantial patent portfolio is a significant part of being successful in cross-licensing," says HP's Fox. His company has between 1,800 and 2,000 patents with an undisclosed number pending. Fujitsu Ltd. claims that by using as bargaining chips its portfolio of semiconductor patents—more than 1,000 in the U.S. and 3,000 in Japan—the company was able to negotiate a cross-licensing pact with TI last year that resulted in "substantially lower royalty payments than Fujitsu has paid in the past," according to a company statement.

Linda Sue Scott

Careless cross-licensing can lock a company out of its own market, warns attorney Tim Covington

But cross-licensing can backfire. Covington says that the licensor must spell out how the licensed technology can be used, whether the licensee has the right to improve on the patented material, and if so, who owns rights to the improvements. "Failure to ask and answer those questions can result in strategic relations that, in time, lead to the demise of the licensor," he says. The problem is particularly acute when U.S. companies license technology to Japanese manufacturers, which improve the technology, patent the improvements, and close the licensor out of its own market.

THEN THERE'S WHAT some call the dark side of intellectual property—the use of patents and other protected material as competitive weapons or revenue generators. TI has come under fire for its aggressive attempts to collect—some say "extort"—royalties based on its portfolio of more than 5000 patents. TI has received some $800 million in royalties for its patents since 1986. "Just as no one should expect to get our products or our services for free, no one should get our inventions for free," argues Dick Agnich, senior vice president and general counsel at TI.

AT&T, meanwhile, is suing chip maker Integrated Device Technology Inc. (IDT) of Santa Clara, Calif., for royalties on a half dozen patents relating to semiconductor production. Part of the suit claims that AT&T is owed royalties on IDT semiconductors because those chips are manufactured using Applied Materials Inc. equipment, which in turn uses an AT&T-patented clamp to hold silicon wafers, says Jack Menache, IDT vice president and general counsel.

MENACHE WORRIES THAT companies such as TI and AT&T are demanding royalties far out of proportion to the contribution their technologies make to the final product. Menache also points to TI's earlier attempts to wring what he calls "unreasonable royalties" from several chip makers for its patented concept of encasing semiconductors in 25-cents worth of plastic packaging. Other sources estimate the size of the royalties sought by TI and AT&T at about 3%.

Unclear is just what this means in terms of fostering or hindering the electronics industry's innovative abilities. Proponents of an aggressive intellectual-property protection approach argue that safeguards are needed to guarantee a profitable return on innovation. Without intellectual property protection, according to AMD's Ishimaru, "I suspect you would have no improvements at all." Others argue that taking intellectual-property protection to the extreme hinders innovation, particularly among small cash-strapped companies.

All this angers Cyrix's Rogers, who argues that intellectual-property laws were meant to encourage innovation and so benefit society; offensive uses of patents and copyrights circumvent that intent. He vows not to play the game. "We're just going to out-innovate our competitors," he says. ☐

A global guide to PATENTS

Going for a Japanese patent? Plan ahead

By Paula Doe

Quick, name the country featured on a provocative public broadcasting special a few months ago that targets foreigners with its unfair patent system. If you guessed Japan, guess again. It's the United States, according to Japanese government-owned NHK Television Network's "America's Patent Strategy—Targeting Japanese Business," which aired in Tokyo in November.

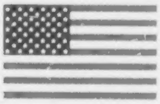
The program presented Japanese companies as being hounded by U.S. infringement suits and noted the disturbing U.S. emphasis on the broad protection of original ideas. The narrator noted that the U.S. would judge an invention as an infringement if its basic idea were the same as someone else's—even if the method or mechanism were different.

That pretty well sums up the difference between the Japanese and

Continued on page 40

U.S. patent system favors the "little guy"

By Rick Whiting



The U.S. patent system is singularly American: It emphasizes protection of individuals' rights, but it also makes litigation hard to avoid.

Unlike nearly every other country, which awards patents to the first to file an application, patents in the U.S. are granted to whomever came up with the invention, innovation, or idea first. The upside of that system is that the rights of the proverbial "little guy" are preserved.

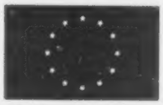
The downside is that the U.S. approach can mean lengthy court battles over the question of who invented what first. "It's probably the fairest, but probably the most difficult to enforce," says Mikio Ishimaru, director of technology law and associate general counsel at Advanced Micro Devices Inc. in Sunnyvale, Calif., of the U.S. patent system.

As with the post office, it has be-

Continued on page 40

Europe offers a variety of patent options

By Barbara N. Berkman



A U.S. company has several options for securing a patent in Europe. All of them are expensive—typically more than $10,000 in up-front costs—and the type of protection varies from one to another.

For now, there is no such thing as a European Community patent, and progress toward the one outlined by the European Patent Convention (EPC) of 1975 has been slow. Moreover, intellectual property rights are largely exempt from the open-market provisions of the harmonized European market; a French patent, for example, is not recognized in Germany or Britain.

Whichever method you choose to secure a European patent, you must consider how the process could be affected by intellectual-property laws—not only in Europe, but elsewhere in the world. While the U.S.

Continued on page 42

International patent rules at a glance

	🇺🇸	🇪🇺	🇯🇵
Length of process	18-24 months average	44 months average (European Patent Office)	4 to 6 years
Cost of process	$5,000-$15,000	$10,000 and up plus translation costs	$8,000 to $15,000 initial costs; more when problems occur
Renewal fees	$900 (3½ years) $1,810 (7½ years) $2,730 (11½ years)	Annual fees differ between countries	Annual fees range from $100 in first year to $4,000 by 20th year
Grace period between disclosure and filing dates	1 year	Six months (limited)	Six months (limited)
Length of protection	17 years	20 years from filing date	15 years from application publication; 20 years from application date
Criterion for patent award	First to invent	First to file	First to file
Publication of innovation	When patent is awarded	18 months after filing application	18 months after filing application
Challenges to patent	Litigation after patent is awarded	Within 9 months after patent is awarded	Competitors may file opposition to delay patent
Other forms of protection	Copyrights, trademarks, semiconductor mask work	Copyrights, trademarks	Copyrights, trademarks, new trade-secret and service-mark registration laws
Strength of patent system	Emphasizes protecting the "little guy"	EPO offers single application point for 15 countries	More thorough process; disseminates technology throughout society
Weakness of patent system	Encourages litigation	EPO rejection elimates option of filing application in individual countries	Slow approval process; big companies have an advantage
Breadth of interpretation	Broad interpretations of original ideas	Scope of patentable subject matter is somewhat limited	Scope of patentable subject matter is somewhat limited
Modification options	Applications can be amended; patent cannot be changed once issued	Applications cannot be amended; patent scope can be narrowed after patent issue	Separate patents are granted for improvements and invention variations
Notes on reciprocity	U.S., Japanese, and European patents are not reciprocal. But all major countries observe such international treaties as the Patent Cooperation Treaty, which recognizes the initial filing date in one country as binding in others if later applications are filed within one year.		

Source: ELECTRONIC BUSINESS, *Electronic Trend Publications*

Continued from page 38

U.S. intellectual property systems. In Japan, the goal of the system is not to protect the individual inventor, but to spread technology.

The result is what some U.S. companies might regard as a disturbingly narrow interpretation of intellectual property claims; if a company patents a bicycle, for instance, another could patent one with a basket, or a different seat. The rules of interpretation apply to all companies doing business in Japan, not just foreigners, according to Shigeru Miki, a patent lawyer at Miki Law and Patent Office in Tokyo. "Japanese companies aren't happy either," he says.

CHANGES ARE IN the works—Japanese patents are being extended to cover software, for example, and this April a new trade-secrets law will bring Japan in line with other developed countries. Still, the Japanese system will generally afford less protection than the U.S. system. When Fusion Systems Corp. in Rockville, Md., patented a high-intensity microwave lamp, their competitor Mitsubishi Electric Co. filed for patents on a similar lamp of a different shape, as well as on the clamp that holds the system together, along with approximately 300 other related patents, making it difficult for Fusion to sell its lamp without licensing Mitsubishi technology.

As in some European countries, moreover, applications in Japan are published years before patents are granted. Separate patents are granted for improvements and variations on an invention. That means a company can head off a competitor's patent by "cluster filing" its own related patents. "When Toshiba sees NEC filing something, they could say 'That's basically what we're doing' and file their own patent," explains David Livdahl, partner at Graham & James in Tokyo. "So when NEC is issued a patent, Toshiba will be close to getting one, too." As a result, the two companies will have to cross-license each other's technologies.

Such problems can be minimized by careful preparation of the patent application. Don't file a direct translation of the U.S. application in Japan—get it rewritten by someone who knows the Japanese system. At the very least, have the translated Japanese applications translated by someone else back into English for checking. And watch the Official Patent Gazette to see who's filing related patents so you can oppose them before they limit the usefulness of your patent.

U.S. companies also complain that once the application is published, it seems to take forever to get a Japanese patent—normally four, five, or even six years. The extended process does serve to weed out invalid claims during application instead of with litigation afterwards, but competitors have access to the technology the entire time. More than 500,000 applications a year are reviewed by about 900 Patent Office examiners—half as many as in the U.S., which processes one-quarter as many applications. Delays are longer in areas where many patents are filed, such as electronics. Computer-related patents in Japan ballooned to 20,000 in 1990, nearly 8% of all patents granted.

Patents can also be delayed by opposition filed by competitors, which also tends to screen out invalid claims. In practice, only a small percentage of patent applications are opposed, but major applications can be delayed by floods of oppositions, all of which must be translated and responded to individually.

The Japanese are making some strides toward speeding up the system by adding more examiners and a new computerized filing system. They are also subcontracting some of the application processing and urging Japanese companies to file fewer patents. There is a fast-track examination system if competitors are close to closing in on an invention. From the Japanese government's point of view, however, the fact that delays allow more companies to use a technology is not a big problem, so progress in improving the process can be painfully slow.

Another big change taking effect in April is a new trade-secrets law that brings Japan up to standards of other developed nations. It remains to be seen exactly what this will mean. "No one knows what the law will do," notes Livdahl of Graham and James. "But I'm sure it will somehow be applied in a very Japanese way and end up very different from the U.S." □

Continued from page 38

come fashionable to bash the U.S. Patent and Trademark Office for slowness. But most corporate attorneys that deal with the PTO on a regular basis say that the department's performance has improved in recent years, and that patent applications that once took three to four years to process are now turned around in 18 to 24 months.

The PTO is not without its critics, however. Ron Collett, an attorney and Dataquest analyst, says the electronics industry is ill-served by the U.S. patent system. Even 18 to 24 months to process a patent application is too long for an industry known for its short product lifespans, he says.

Estimates of the costs of applying for a patent in the U.S. range from $5,000 to $15,000. The initial filing fee is $690, and there is an issue fee of $1,130 if the patent is approved. Patents are good for 17 years but must be renewed after three and one-half, seven and one-half, and 11 and one-half years for fees of $900, $1,810, and $2,730, respectively. All fees are reduced by 50% for companies with 500 or fewer employees, individual inventors, and nonprofit organizations.

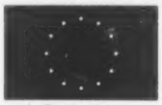
Warning: If any information about a company's new technology or innovation is disclosed before patent application, the invention may be considered "in the public domain" and the right to protection lost. As a result, executives, engineers, and other employees must be careful about what they reveal in speeches, papers, and other public forums.

That can make timing a critical issue, since patent applications in other parts of the world are made public after a certain amount of time. In Europe, for example, that occurs 18 months after filing an application. If that happens before a U.S. patent application is filed, protection in the U.S. can be lost. Applications in the U.S. are kept confidential until the patent is awarded. If the application is turned down, the information is never disclosed.

ANOTHER QUIRK in the U.S. system: Working models of inventions are no longer required, and patents can be awarded based on a plan or design. That also favors the individual inventor and makes answering the all-important question "who was first?" even more difficult.

Copyrights are automatic for written material and software, although they can be formally registered with the U.S. Copyright Office (part of the U.S. Library of Congress) for a $20 filing fee. Protection for semiconductor mask work under the Semiconductor Chip Protection Act of 1984 is also obtained through the Copyright Office. ☐

Continued from page 38



grants priority to the first to invent the product, for example, Europe and Japan recognize the first to file an application.

Note also that, while Europe does not recognize U.S. patents, the date on which you apply for a U.S. patent is recognized in Europe as the official filing date (the "priority date") for the purposes of intellectual-property protection, as long as an application for a European patent is filed within one year.

Another important caveat is that you must not disclose anything about your invention, *anywhere in the world*, before you apply in Europe. If you first apply for a U.S. patent, or if you first discuss your innovation at any conference, seminar, or in a publication, "you've had it," warns European patent attorney Robert Naismith, a partner with Chartered Patent Agents Cruikshank & Fairweather in Glasgow.

Because of the high cost, get an assessment of your invention from a European Patent Attorney who is authorized to act before the European Patent Office (EPO), or from a Chartered Attorney in the U.K. The initial assessment usually is free. After such a consultation, the cost often dissuades U.S. companies from proceeding, says Naismith. To save money, companies may alternatively decide to protect themselves only in their major European markets. In any case, get a reputable patent attorney who can describe the invention concisely to minimize translation costs.

THE CONFUSION COMES in deciding which intellectual-property option to choose. Each has its advantages and drawbacks.

The Munich-based EPO, the closest thing to "one-stop shopping" for patents, issues a single European patent that is registered in up to 15 of the member countries of the European Patent Convention. The application is usually filed within a year of filing in the U.S., and the initial examination and search is conducted by the EPO.

The key advantage, of course, is the multinational protection. Be warned, though, that the patent offices of the signatory nations may not interpret or enforce the patent in a consistent way. British and German courts disagreed on a recent consumer-electronics infringement case, for example.

Remember that an EPO patent puts all your eggs in one basket. If the EPO rejects the patent, you can't try again later at any of the national patent offices in the same countries.

European patents also are available in accordance with the 49-country Patent Cooperation Treaty, or Euro-PCT. Following an international search, your application goes through an international preliminary examination. You must file regional or national patent applications (at the EPO, for example, or the U.S. or Japanese patent office) in the nations you specify; those agencies then decide whether to grant the patent.

ONE OF THE ADVANTAGES here is the 30-month "international phase" period between the initial U.S. filing date and the deadline for entering the European phase. This delay means that you defer payouts of European filing fees and national phase filing fees, which are a huge chunk of the application costs, until you have an assessment of the invention's patentability. The main disadvantage is that the Euro-PCT route, like an EPO patent, costs roughly $10,000 just to get your application filed. Later, translation fees can run several thousands of dollars if the specification is lengthy.

If you want protection in just three or fewer countries, it may be better to go directly to the national patent offices. That saves money in translation and filing fees. (A translation of up to 35 pages costs about $565 per language.)

The disadvantage, however, is that you commit to filing fees without having a search or examination first carried out by the U.S. Patent and Trade Office, a step that often allows you to gauge if you should file overseas. Lacking protection elsewhere in Europe, "you leave yourself open to parallel importation, and it is likely that someone else will start manufacturing in that country," says Morag Macdonald, a partner at London law firm Bird & Bird. "If you have a broad market, make sure that you designate all the countries." ☐

U.S.-Japan chip pact stalls. Now what?
PAGE 11

European RF/EMI rules create niche market
PAGE 11

Memory card sales to rise, profits to fall
PAGE 45

C1850-2A

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE
MARCH 16, 1992

THE PATH TO EXPORTS

BANK OF WORLD
100
Y
$
£
DM

Steering clear of the regulatory traps
PAGE 22

Using currency rates to your advantage
PAGE 30

The big payoff: The 100 top exporters
PAGE 39

Electronic Business

VOLUME 18 NUMBER 5

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE

MARCH 16, 1992

[illegible]

COVER STORY

22 The path to exports
The Cold War may be over, but U.S. electronics companies still say they're losing millions to Washington's outdated export-control policies

30 Hedge your currency risks now
Closely integrated world markets mean that a falling dollar or rising yen could cut your overseas sales profits by 20%

39 Export boom takes a breather
Big winners in 1990 were Sun, Motorola, and Cadence. IBM was on top (again) with $6.2 billion

40 Top 100 exporters table

FEATURES

Markets

45 Memory card forecast: a 62% jump in 1992
Soaring demand means big profits now, but slippage in selling prices all but guarantee a commodity bloodbath—as in DRAMs—by 1995

PAGE 45 Memory card volume growing faster than revenue

UPFRONT

Business Trends

11 The U.S.-Japan chip pact isn't working; 1992 European RF/EMI rules spur new test markets; Brace for brawl over bill to kill quarterly reports; Intergraph redraws Poland's maps

PAGE 11 Intergraph makes it easier to get around Poland

DEPARTMENTS

Inside Business

7 Trade-balance remedy begins at home

Business Barometer

19 Indicator points to recovery in progress

Advertiser Index

54 Advertisers covered in this issue

Company Index

54 Companies covered in this issue

My View

56 Tree huggers. And millionaires

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett,
Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

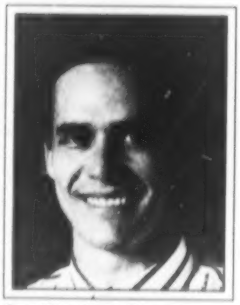
Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Trade-balance remedy begins at home



Contributing editor Dwight Davis

FOR SOME businesses, history presents a moving target: Either anticipate the trends or try to catch up with those who do. Our cover story makes the case that, while Washington could not have foreseen the recent events in the former Soviet Bloc, regulators now must find ways by which U.S. companies can take advantage of those events.

Contributing editor Dwight Davis reports some progress in easing export restrictions on electronics components and systems. Action by the 17-nation Coordinating Committee for Multilateral Export Controls has lifted thousands of names from the list of "core" products that were once considered strategically sensitive. Some officials, however, still appear to be waging the Cold War: Fiber-optics and other badly needed telecommunications technologies can't be exported to parts of the former Soviet Union, for example. And when premier U.S. supercomputer maker Cray Research recently lost out on major sales to Israel and India, it was due to strict export restrictions imposed by Washington and not because of limits set by the international community.

It's those roadblocks at home that electronics executives find particularly galling. A host of federal agencies still have a say in whether products comply with the provisions of several U.S. laws on strategic exports. But political and economic developments have changed drastically the way we view the former U.S.S.R., the chief target of those rules, and that creates a dilemma: In the new world disorder, how can one determine whether a particular trade deal will put strategic technology into the wrong hands?

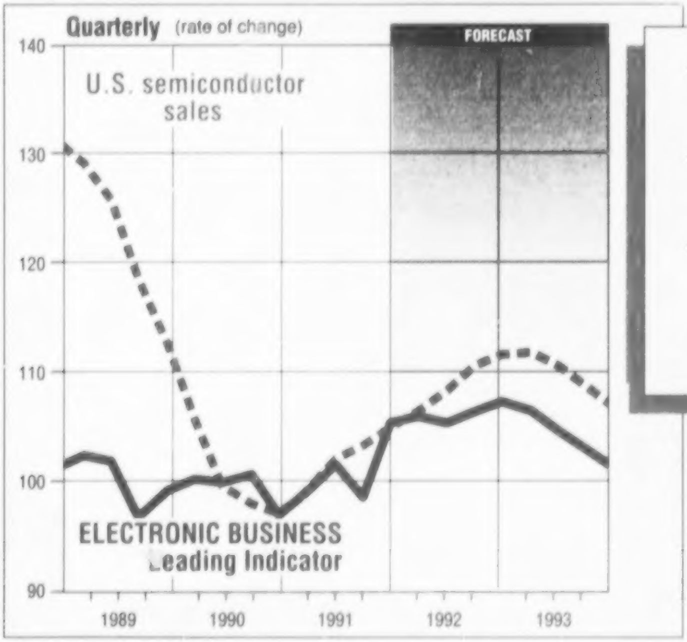
Despite the economic slump, electronics exports from the U.S. are growing, as senior editor Linda Stallmann reports in this issue. Makers of electronic design-automation software and disk drives alone led the charge in exporting $53 billion worth of electronics during the first nine months of last year, about $2.4 billion less than America's total electronics imports for the same period.

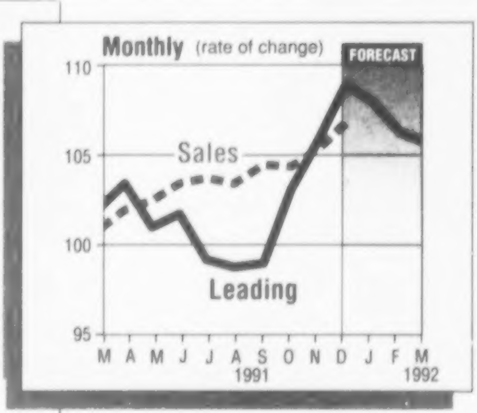
Elsewhere in this issue, contributor Lisa Stapleton describes how U.S. electronics companies are being dragged into the unpredictable arena of world currency markets. Given the growing integration of the world's economies, she writes, even companies that deal entirely on U.S. soil must learn how subtle shifts in foreign currency can show up right on their bottom lines. ☐

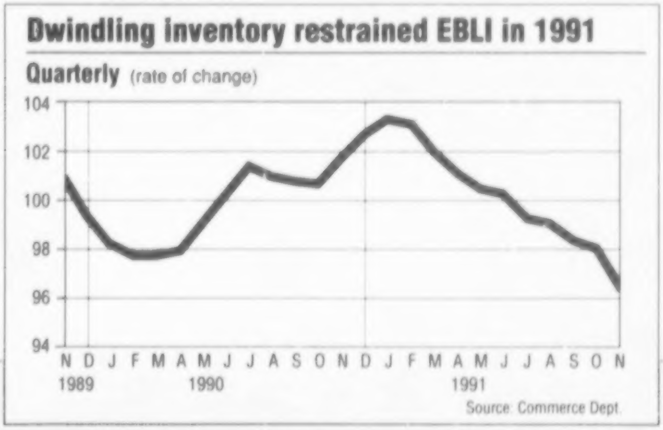
ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA. Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

ELECTRONIC BUSINESS Leading Indicator







Dwindling inventory restrained EBLI in 1991

Source: Commerce Dept.

Indicator points to recovery in progress

IN THE FINAL MONTH of 1990, the ELECTRONIC BUSINESS Leading Indicator (EBLI) fell to a low point of 95.7, warning of a difficult year for the electronics industry in 1991. With hindsight, it is now clear that the Indicator was on target. Having climbed for the past four months in a row to 108.5 by December 1991, does it seem the Leading Indicator is now signaling a bonafide expansion in 1992? Yes, but don't expect anything near the record growth of 1988. The EBLI peaked at 120 after the 1986 slowdown, but the Indicator is not expected to break the 110 barrier in the next two years.

—*John Farrell*

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Dec.)	108.5	105.6	95.7	99.9
U.S. semiconductor bookings ($ millions, 3-month average, Dec.)	$1,400	$1,337	$1,207	$1,254
Weekly hours of semiconductor production workers (monthly average, Nov.)	41.7	41.6	40.8	40.4
Electronic components lead time index (1977 = 100, Jan.)	83.6	91.9	73.9	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, Dec.)	66.3	64.3	57.4	64.6
Change in electronic components inventories ($ millions, SA, Nov.)	-$199	-$53	$58	$33
Contracts and orders for plant and equipment ($ billions, SA, Nov.)	$37.9	$34.9	$36.5	$38.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119, fax (617) 630-2100

THE PATH TO EXPORTS

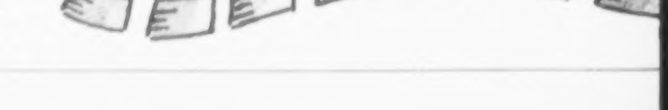
As Cold War-era export controls slowly abate, new U.S. policies burden electronics shippers

By Dwight B. Davis

Two months ago, Cray Research got word that Technion University in Haifa, Israel, had changed its plans. Rather than buying one machine from the Eagan, Minn.-based supercomputer maker, Technion had decided to buy two from Britain's Meiko Scientific Ltd.

The news by itself was bad enough. But what *really* hurt was that the sale had been torpedoed not by Meiko's superior technology, but by the U.S. government. "Technion was willing to open its doors to U.S. inspectors and had agreed to any restrictions that our government deemed necessary," says Lisa Kjaer, Cray's senior manager for international trade affairs. "But the government just kept delaying action on our license request." Technion officials apparently concluded that the sale wasn't going to be permitted, Kjaer says.

Cray isn't the only company to see its business shredded by the wheels of government. While U.S. export controls have eased somewhat with the collapse of the former Soviet Bloc, some exporters claim they're still mired in a maze of regulations that is designed largely to limit weapons proliferation and that undercuts their competitiveness. Others complain they must devise complex, costly, time-consuming procedures to ensure their companies' compliance with the law. "Exporting is more complex than ever," says David



Rose, manager of import/export affairs for Intel Corp.

Nor will it get easier soon. U.S. exporters today must cope with a swelling array of rules—including the Export Administration Act, the Arms Export Control Act, and the Nuclear Non-Proliferation Act—that are overseen by the Departments of Commerce, State, Defense, and Energy, as well as various intelligence agencies. "It's a bureaucratic morass," says Kevin Shannon, director of the Electronic Industries Association's International Business Council in Washington. The results, according to some exporters: legal liability for exports that end up in the wrong hands, hefty fines for those who break the rules, and big chunks of business lost to unreasonable paperwork delays.

Computers buoyed U.S. exporters in '91

($ billions)

Exports 1990	Exports 1991	Industry sector	Imports 1990	Imports 1991
29.43	31.48	Computer/industrial	22.32	25.44
12.18	11.27	Solid state products	10.12	10.90
6.66	6.80	Communications	6.42	6.47
6.01	6.09	Passives*	7.65	7.83
2.00	2.21	Consumer electronics	11.95	11.84
.42	.55	Electron tubes	.43	.45

*includes electromechanical components
All data are for first 10 months

Source: U.S. Dept. of Commerce, Electronic Industries Assn.

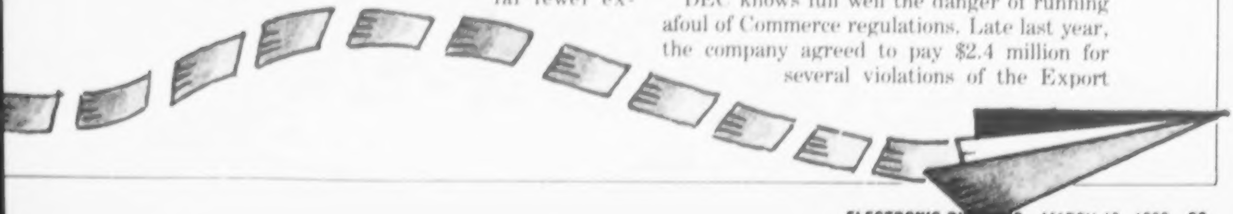
FOR DECADES, the U.S.'s export policy was set largely by the Coordinating Committee for Multilateral Export Controls (CoCom)—a 17-nation group that cooperatively sets restrictions on its members' strategic exports. CoCom publishes a "core list" of products that require licenses; the U.S. Department of Commerce, in turn, uses the core list to construct much of its own Commerce Control List. Prompted mostly by reduced East-West tensions, CoCom last year dramatically slashed its core list (see "Liberalized export rules get mixed reviews," p. 25).

Unlike the CoCom rules, however, the antiproliferation regimes apply unilaterally to U.S. exporters. They also apply to *all* products, including those that have been decontrolled by CoCom. More ominously, exporters must investigate the likely use of their products by foreign clients; if a customer uses a product for proscribed activities or diverts it to another user or country for such use, the U.S. seller may have to prove that it went to reasonable lengths to screen the customer first. So, while far fewer exports now need to be licensed, "the one that does requires that the exporter use his judgment about the intended use of the product," warns Jim Fitzgerald, president of Washington-based export consultants Fitzgerald & Associates.

The problem, according to many electronics exporters, is that customer-screening requirements are ambiguous, as are the penalties for infractions. Various laws provide for both civil and criminal penalties, but the Commerce Department's "death sentence" for an exporter is the denial of all export privileges, notes John Black, a senior consultant at MK Technology Deltac, an export consulting firm in Harisonburg, Va. "The government would never apply that penalty to a large legitimate exporter because it could drive it out of business," he says. Still, exporters go to great lengths to avoid penalties of any kind, along with the attendant bad publicity.

This increased responsibility, combined with the multiplicity of control regimes, puts additional pressure on exporters. "To determine if a product is decontrolled, we have to go through a decision-tree analysis that would run three to four pages if we printed it," says Lee Mercer, corporate export manager for Digital Equipment Corp. Although the number of products controlled and licenses required is down, he says, "the complexity of exporting and our cost of business is up."

DEC knows full well the danger of running afoul of Commerce regulations. Late last year, the company agreed to pay $2.4 million for several violations of the Export



What you can—and can't—sell abroad

Under new export rules, computers are rated according to their "composite theoretical performance." That, in turn, is determined by the computer's sophistication expressed in "millions of theoretical operations per second," or MTOPS. Most PCs and workstations are rated at 12.5 MTOPS or less.

MTOPS	Remarks	Example
Less than 6.0	The maximum level that can be shipped to Iran and Syria	DEC VAX 4000-300
6.0-12.5	Decontrolled for all countries except Iran, Syria, and embargoed nations *	DECstation 3100; Intel 486 33MHz chip
12.5-20	Computers can be exported at discretion of producer's home country. No CoCom-level approval required	Intel i960 40 MHz Intel 486 50 MHz
20-23	Favorable consideration for export to China, former USSR, and East Bloc countries. Subject to veto by any CoCom nation	DECstation 5000, model 133
20-41	Favorable consideration for sale to Poland, Hungary, and Czechoslovakia. Subject to veto by any CoCom nation	DECstation 5000, model 240
23 and above	"General exception" category for China, former USSR, and East Bloc countries. Shipments must be approved by all CoCom members	VAX 9000, model 210
41 and above	"General exception" for Poland, Hungary, Czechoslovakia	Intel i860 50 MHz
195-1950	First "supercomputer" category, subject to wide restrictions. License needed for all destinations except Japan	VAX 6000, model 560
1950 and above	Subject to intense restrictions; all shipments require licensing	Most computers from Cray Research

*Countries currently embargoed include North Korea, Vietnam, Cuba, Libya, Iraq, and Haiti.

Source: Digital Equipment, Sun Microsystems

Administration Act. Despite the size of the fine—the largest civil penalty ever imposed for export control violations—the infractions were relatively benign, a DEC spokesman claims. In 31 instances, he says, DEC shipped computer systems after applying for licenses, but before receiving them. The unlicensed shipments occurred between mid-1986 and early 1989, during which time the company applied for and received more than 3,000 export licenses. "In all but the last of the 31 cases, licenses were issued within days of the shipments," the spokesman says. In the last case, DEC withdrew the shipment before the license request could be acted upon. "The people who jumped the gun on the shipments are no longer with the company," he says, "and there was never any compromise or suggested compromise to the national security."

Compliance for a large computer company such as DEC, however, is far from simple. "We handle from 200,000 to 300,000 saleable options, all of which must be classified by country eligibility and level of technology," says Bob Rarog, DEC's export policy manager. Any given computer system may contain hundreds of hardware-software combinations, he notes. DEC codes each of the thousands of options and uses its system to compile a licensing profile of each system whenever an order is booked. In addition, the company uses an internal "denied parties" list to screen out buyers who have been blacklisted by the Departments of Commerce, Treasury, or State.

Like many large exporters, DEC does most of its export business via government-issued distribution licenses—bulk licenses that specify which products can be shipped to which countries with no further licensing requirements. About 90% of DEC's

Liberalized export rules get mixed reviews

LAST YEAR, the 17-nation Coordinating Committee for Multilateral Export Controls (CoCom) slashed its core list of export-restricted products; the new list, which makes up much of the Commerce Department's Control List, took effect in September. "The level of decontrol is more far-reaching than in the past," says David Rose, manager of import/export affairs for Intel Corp. "Not long ago, virtually every chip we exported needed a license."

The new list decontrols all dynamic random access memories (DRAMs) and microprocessors equivalent to a 40-megahertz 386 chip. The Commerce Department claims its current control list represents a 25% reduction in the number of microelectronics products requiring licenses.

Semiconductor equipment manufacturers also scored some gains under the new rules. Some products—sputtering machinery, inspection equipment, and silicon wafer-processing devices—are completely decontrolled, notes Victoria Hadfield, manager of government relations for Semiconductor Equipment Manufacturers International, an industry association. Controls on other products, such as lithographic equipment, have been reduced. In the past, for example, devices that could produce chips with 3- to 5-micron line widths were controlled; the new list lowers that to 1.5 microns.

The Commerce Department claims its current control list reduces the number of microelectronics products requiring licenses by 25%

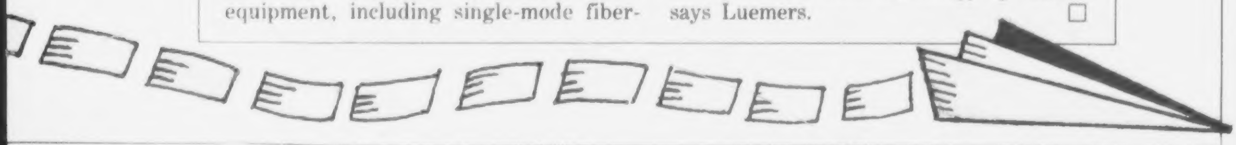
Telecommunications shipments to the former U.S.S.R., however, are still unfairly restricted, according to Chris Padilla, manager of government relations for AT&T. Western suppliers can lay high-speed communications cables up to the region's borders, but they then must shift the traffic to low-speed lines. "It's like connecting a 10-lane superhighway to a country road," he says. Nor can telecom companies ship certain types of switching or transmission equipment, including single-mode fiber-optic cable, to the region. The reason, speculates Padilla, is that such equipment makes it harder for Western nations to tap the lines. As a result, he says, the former U.S.S.R. states can't buy equipment that is routinely sold to China or build a telephone system to match that of even a third-world country.

The effect of the new core list on computer producers is less clear. As part of the revision, CoCom introduced a new measurement of computer sophistication—composite theoretical performance, or CTP. Computers with a CTP ranking of 12.5 million theoretical operations per second (MTOPS) or less (which includes most PCs and workstations) are decontrolled for export to most countries (see "What you can—and can't—sell abroad," page TK).

For some, the revisions have had little effect. "We don't benefit from the 12.5 level of decontrol," says Hans Luemers, manager of export controls at Sun Microsystems Inc. "Products below that are obsolete for us."

At the upper end of the computing spectrum, the CTP scale defines supercomputers as machines rated at 195 MTOPS or more—a ridiculously low level, many exporters charge. "If the level is not raised significantly, it will catch commodity products such as servers and desktop computers," warns Luemers. Top-of-the-line supercomputers now perform in the 10,000 to 20,000 MTOPS range, says Lisa Kjaer, senior manager for international trade affairs for Cray Research Inc.

Indeed, the core list and other export-control regimes often fail to keep pace with technological advances. For now, about one-third of the CoCom core list is reviewed every two years. With computer performance levels doubling about every 18 months, that schedule "trails technology by miles," says Luemers.



exports are shipped under distribution licenses, according to Rarog. To keep the distribution licenses in place, the company annually rescreens every foreign customer with an extensive questionnaire designed to flag potential product misuses or diversion. (Similar forms for prescreening foreign buyers are available to any exporter from the Commerce Department.)

DEC has about 120 export-control specialists. Smaller exporters that lack that expertise may find consultants useful. MK Technology Deltac, for instance, has its own distribution licenses that may be used to ship clients' products; that typically involves an annual retainer of $5,000 and up, says consultant Black. Other services include helping clients classify their products for export and shepherding export applications through the bureaucracy when licensing is required. The latter service varies by complexity; a license for exporting to China, for example, typically ranges between $350 and $500.

Despite some easing in export controls, "our cost of business is up," says DEC's Mercer

Another trouble spot for U.S. exporters is the gray area known as "administrative exception notes," or AENs. Certain computers and other products that fall into this category require no CoCom-level license but are subject to license at the country of origin's discretion. Some charge that U.S. exporters have suffered in the past because Washington has been more prone than its CoCom partners to restrict AEN-category products. "State Department officials admit that in the rest of the world, the AEN rating is tantamount to decontrol " says Howard Lewis III, vice president of international economic affairs at the National Association of Manufacturers (NAM).

In the past, AEN-category products were subject to review by any U.S. government agency that might object to their shipment. Under current export policy, the Department of Commerce can process and approve AEN license applications without any interagency review. Most license requests are processed within 72 hours, according to consultant Fitzgerald.

Some exporters disagree. "The President promised that by Jan. 1, 1991, AEN reviews would take no longer than 15 calendar days," says Chris Padilla, manager of government relations for AT&T. "We did a study in June 1991 and found that some of our applications were still taking from 45 to 60 *working* days to get approved."

AT&T and other large electronics companies take a proactive approach to speeding AEN reviews and other licensing delays simply by staying in close touch with the Commerce personnel who are assigned to the request. "The process is a back-and-forth dialogue," says DEC's Rarog. "We can't afford to just sit and wait."

Sitting and waiting, though, is exactly what some exporters do—and, they say, they lose business as a result. Cray's Kjaer claims to have lost "several outstanding orders," besides the Technion sale, to licensing delays. With a typical Cray supercomputer sale bringing in as much as $30 million, the effect of cancellations due to delays can be severe.

Nor is business lost only to what some call a glacial pace in Washington. On one occasion, Cray had been permitted to sell a midrange system to a weather center in India subject to "onerous" regulations: The Indian facility had to be guarded 24 hours a day, and the U.S. dictated which applications could be run on the machine. "So the Indian government started its own supercomputer program," Kjaer says. India's Center for Development of Advanced Computing has since produced its own supercomputer, the Param, and has sold at least two systems to the former Soviet Union. "U.S. export controls essentially created a foreign competitor" in a country that ships supercomputers to destinations forbidden by the U.S. government, says Kjaer.

To some observers, such government meddling, along with complex and outdated export controls, hurt the goal of increasing U.S. electronics exports. "It's crazy, since electronics is one area in which we're still competitive worldwide," says the NAM's Lewis. "We can't allow the export debate to remain so one-sided that everybody dives under the table whenever someone utters the words 'national security.' " □

Export boom winds down, but '92 won't be a bust

THE TOP 100 EXPORTERS

Big winners in 1990 were Sun, Motorola, and Cadence. IBM was on top (again) with $6.2 billion

By Linda Stallmann

After a 19% surge in 1989, an 11.7% gain in 1990, and a more modest 6.5% increase during the first nine months of last year, U.S. electronics companies can expect another year of only modest export growth in 1992. "U.S. electronics exports this year will show about the same growth rate as 1991, but with more strength at the end of the year than at the beginning," notes James Haughey, a vice president for economics and research at Cahners Economics in Newton, Mass.

The forecast of modest growth for U.S. electronics exports, after domestic companies shipped almost $53 billion during the first nine months of 1991, can be traced to a combination of factors—less demand due to sluggish worldwide economies, an increase in interest rates, and the diminishing effect of the cheap dollar since the late '80s. "The dollar won't change much in the next few years," Haughey predicts.

Certain sectors—solid-state products and computer systems—continue to show export strength. Computer exports increased by more than $300 million during the first nine months of 1991, the largest dollar gain of any sector, according to the Electronic Industries Association. Essentially, the past is prologue; today's hot exporters will continue to be big sellers.

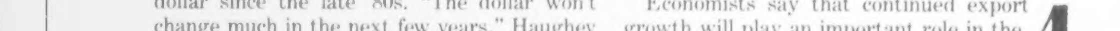
The ELECTRONIC BUSINESS survey of the 100 top exporters in 1990 shows the strength of the major players. It includes companies that represent more than half of the U.S. electronics industry's total exports of $71.6 billion. In fact, the top 10 companies shipped $22.3 billion worth of goods and services, or almost one-third of all electronics exports.

IBM led the list with exports of $6.2 billion, shipping 13.1% more goods overseas in 1990 than in 1989. Third-ranked Motorola Inc. in Schaumburg, Ill., made an impressive showing, improving its export sales by 20.8%, to $2.8 billion. Among the top 10, Mountain View, Calif.-based Sun Microsystems Inc.'s impressive 48.8% increase was the most dramatic.

Interestingly, the fastest-growing exporter was EDA software maker Cadence Design Systems Inc. of San Jose. It was ranked 46 after registering export revenue gains of 170%, to $158 million, due to a substantial expansion of its international sales and marketing efforts.

The losers in the export game include Control Data Corp, whose exports declined 72%, to $129 million, primarily due to the sale of Imprimis, its disk-drive subsidiary. Others that saw exports shrink include Sprague Technologies, down 43%, to $39.8 million; Micron Technology, down 36%, to $76 million; and Amdahl, down 27.7%, to $299.9 million.

Economists say that continued export growth will play an important role in the economic recovery, since it will outpace the growth of domestic sales this year. □



THE TOP 100 EXPORTERS

Electronic Business

1990 rank	Company	1990 exports ($ millions)	% change	1990 exports as % of U.S. sales	Rank	1990 exports as % of U.S. sales	Rank	1990 U.S. sales ($ millions)	1990 total sales ($ millions)
1	**IBM**	$6,195	13.1%	18.6%	76	17.5%	77	$33,327	$69,018
2	**Hewlett-Packard**	2,816	6.9	31.9	37	32.1	37	8,841	13,233
3	**Motorola**	2,801	20.8	32.0	36	28.5	47	8,759	10,885
4	**Digital Equipment**	2,082	-6.5	26.9	50	28.0	50	7,744	12,943
5	**GM Hughes**	1,895	23.8	16.2	85	13.5	89	11,723	11,723
6	Unisys	1,707	-10.5	25.9	53	27.1	52	6,578	10,111
7	Raytheon	1,435	7.1	16.5	82	16.3	82	8,699	9,268
8	Intel	1,202	20.5	36.2	28	36.0	26	3,318	3,921
9	Sun Microsystems	1,117	48.8	47.0	10	42.5	11	2,375	2,466
10	Compaq	1,019	27.9	38.1	25	33.7	33	2,677	3,599
11	**Xerox**	900	16.9	7.5	95	6.4	97	11,983	17,973
12	**Apple**	559	0.1	14.7	88	14.1	88	3,800	5,558
13	**Tandem Computers**	557	32.2	40.2	20	34.9	30	1,386	1,866
14	**Atari**	512	13.9	91.7	3	85.4	2	558	411
15	**Western Digital**	487	105.9	55.7	8	38.3	16	874	1,071
16	Tektronix	467	2.0	38.1	24	37.4	20	1,225	1,408
17	NCR	466	-3.5	16.3	83	16.5	80	2,859	6,285
18	National Semiconductor	421	3.6	31.5	39	30.9	40	1,336	1,675
19	Varian Associates	397	7.9	36.9	27	35.4	29	1,077	1,265
20	Advanced Micro Devices	348	-4.0	40.1	21	38.7	14	869	1,059
21	**Texas Instruments**	336	23.5	7.1	98	5.7	98	4,722	6,567
22	**Microsoft**	324	51.6	37.8	26	36.9	22	857	1,183
23	**Conner Peripherals**	304	-21.8	30.8	41	49.0	9	986	1,338
24	**Amdahl**	300	-27.7	19.1	73	25.4	56	1,571	2,159
25	**Tandon**	282	20.0	94.1	2	89.0	1	300	422
26	AMP	265	13.1	17.7	81	15.5	85	1,503	3,044
27	Maxtor	261	83.6	44.3	14	33.6	34	590	491
28	Cray Research	250	4.6	34.4	33	33.0	36	727	804
29	Tandy	241	7.3	5.7	99	5.5	99	4,202	4,500
30	Storage Technology	238	16.4	26.5	52	24.3	57	898	1,141
31	**Wang Laboratories**	225	-14.0	16.0	87	16.8	79	1,411	2,497
32	**Intergraph**	224	-5.4	28.9	45	34.2	32	776	1,045
33	**Data General**	214	-26.3	25.6	55	30.1	41	837	1,216
34	**LSI Logic**	211	37.1	26.7	51	23.6	60	791	655
35	**Honeywell**	209	-5.1	4.6	100	4.8	100	4,512	6,309
36	Teradyne	199	-8.5	43.3	16	44.9	10	459	459
37	Novell	197	34.4	39.6	22	34.8	31	498	498
38	Applied Materials	194	-7.8	42.9	17	54.6	7	451	567
39	General Signal	192	24.7	13.3	92	10.3	93	1,449	1,695
40	Chips and Technologies	185	49.0	63.0	5	57.0	6	293	293
41	**Loral**	181	31.6	14.2	90	11.6	92	1,274	1,274
42	**Harris**	172	-3.8	7.2	96	9.2	96	2,376	3,053
43	**Medtronic**	162	25.0	24.3	58	23.1	62	668	837
44	**Computer Associates**	160	-9.7	19.2	71	20.6	69	835	1,296
45	**Raychem**	159	8.2	28.1	48	26.8	53	567	1,115
46	Cadence Design Systems	158	170.0	57.0	6	38.0	17	277	231
47	Quantum	143	121.5	32.0	35	31.0	39	446	446
48	3Com	139	2.9	35.7	31	36.2	25	389	419
49	Silicon Graphics	134	49.8	36.0	29	35.9	27	371	420
50	E-Systems	130	-20.4	7.2	97	10.0	95	1,810	1,810

(Continued)

THE TOP 100 EXPORTERS

Electronic Business

1990 rank	Company	1990 exports ($ millions)	% change	1990 exports as % of U.S. sales	Rank	1990 exports as % of U.S. sales	Rank	1990 U.S. sales ($ millions)	1990 total sales ($ millions)
51	**Control Data**	$129	-72.0%	10.1%	94	18.9%	72	$1,278	$1,278
52	**Analog Devices**	127	16.9	35.8	30	32.0	38	355	485
53	**Gerber Scientific**	125	-1.4	40.8	19	42.5	12	307	307
54	**Perkin-Elmer**	124	8.1	24.0	62	23.3	61	518	838
55	**Scientific-Atlanta**	117	6.7	19.0	75	20.0	71	614	614
56	**VLSI Technology**	113	29.4	38.5	23	33.5	35	293	325
57	**Symbol Technologies**	108	8.8	56.0	7	53.0	8	193	232
58	**Oracle**	106	57.5	17.7	80	18.2	74	598	971
59	**Dell Computer**	104	64.3	22.5	64	17.4	78	463	546
60	**ESCO Electronics**	99	-10.0	18.3	79	18.3	73	538	538
61	**Westmark International**	93	31.5	21.8	66	18.2	75	425	485
62	**Diebold**	91	59.8	19.2	72	12.2	90	476	476
63	**Watkins-Johnson**	87	-1.8	29.1	44	29.5	44	299	312
64	**Archive**	81	60.0	27.7	49	28.0	51	293	293
65	**Convex Computer**	81	17.6	45.7	12	58.5	5	176	209
66	**AST Research**	79	-12.7	18.4	77	21.0	68	429	534
67	**Micron Technology**	76	-35.6	22.7	63	26.3	54	333	333
68	**International Rectifier**	74	45.8	43.4	15	35.9	28	170	230
69	**Andrew**	73	23.4	25.9	54	25.6	55	282	366
70	**MAI Systems**	72	2.4	45.0	13	29.5	43	161	389
71	**Stratus Computer**	69	7.5	24.0	60	21.8	67	288	404
72	**Burr-Brown**	68	-11.7	53.5	9	58.8	4	127	177
73	**Analogic**	66	22.1	46.3	11	37.5	19	144	144
74	**Cubic**	65	84.3	18.3	78	10.0	94	353	353
75	**Esterline**	64	21.4	20.1	69	23.6	59	317	389
76	**KLA Instruments**	62	24.4	100.0	1	36.6	23	62	168
77	**Pyramid Technology**	57	45.5	34.7	32	39.0	13	165	180
78	**Everex Systems**	57	6.6	14.6	89	15.9	84	388	437
79	**DSC Communications**	56	27.7	10.8	93	11.7	91	519	519
80	**GenRad**	55	-0.6	41.1	18	37.0	21	135	179
81	**M/A-Com**	55	30.7	16.2	84	16.4	81	341	375
82	**General DataComm**	55	2.4	29.5	43	29.7	42	186	202
83	**Silicon Valley Group**	55	11.4	31.6	38	38.6	15	173	184
84	**Dynatech**	52	2.9	14.1	91	14.9	87	369	433
85	**Concurrent Computer**	52	81.4	21.6	68	15.0	86	239	340
86	**Datapoint**	51	-25.5	68.4	4	60.6	3	75	267
87	**Integrated Device Technology**	50	20.9	24.0	61	23.0	63	209	209
88	**Cypress Semiconductor**	50	8.1	22.0	65	23.0	64	225	225
89	**Sequent Computer System**	49	17.8	24.2	59	36.4	24	204	249
90	**Vishay Intertechnology**	49	12.8	19.2	70	18.1	76	254	446
91	**QMS**	49	45.0	21.7	67	20.1	70	224	276
92	**Measurex**	47	-25.4	33.1	34	37.6	18	143	266
93	**Coherent**	46	0.5	30.8	40	28.7	46	148	191
94	**Kollmorgen**	44	7.0	24.4	57	22.2	66	180	239
95	**Intermec**	43	36.7	25.6	56	24.0	58	168	168
96	**Autodesk**	43	32.7	28.8	47	28.5	49	149	238
97	**Encore Computer**	42	31.6	29.9	42	22.7	65	141	215
98	**ADC Telecommunications**	42	33.1	16.0	86	15.9	83	260	260
99	**Aydin**	41	-11.4	28.8	46	29.4	45	142	142
100	**Sprague Technologies**	40	-43.1	19.0	74	28.5	48	209	315

Solbourne and Matsushita: How a good idea went bad
PAGE 86

Compaq and Conner take the guesswork out of alliances
PAGE 137

Wanted: U.S. contenders for $4 billion LCD market
PAGE 11

A CAHNERS PUBLICATION

Electronic Business®

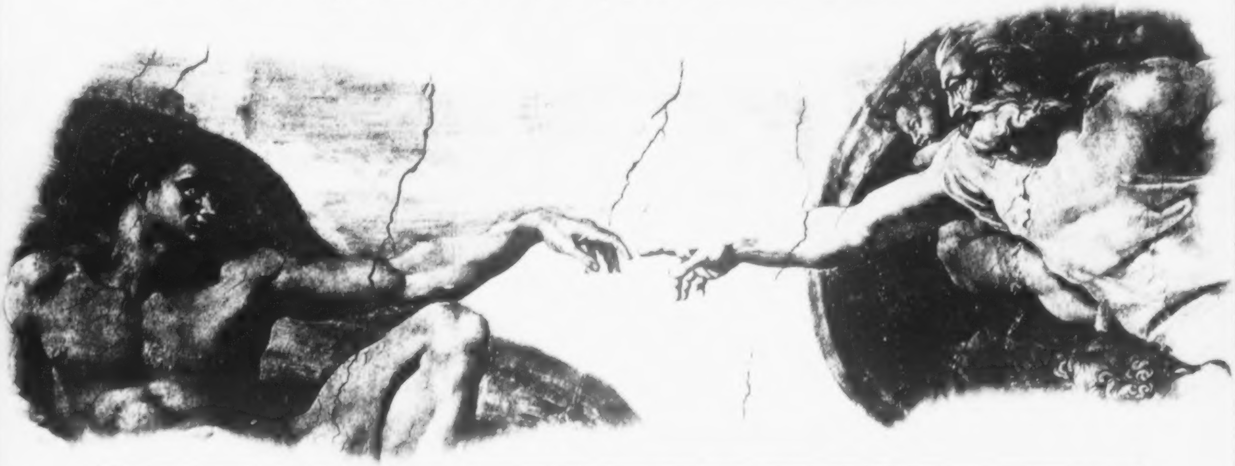
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES WORLDWIDE

MARCH 30, 1992

3rd Annual CEO Survey

STRATEGIC ALLIANCES

Exclusive Survey of Chief Executives by Electronic Business and Ernst & Young



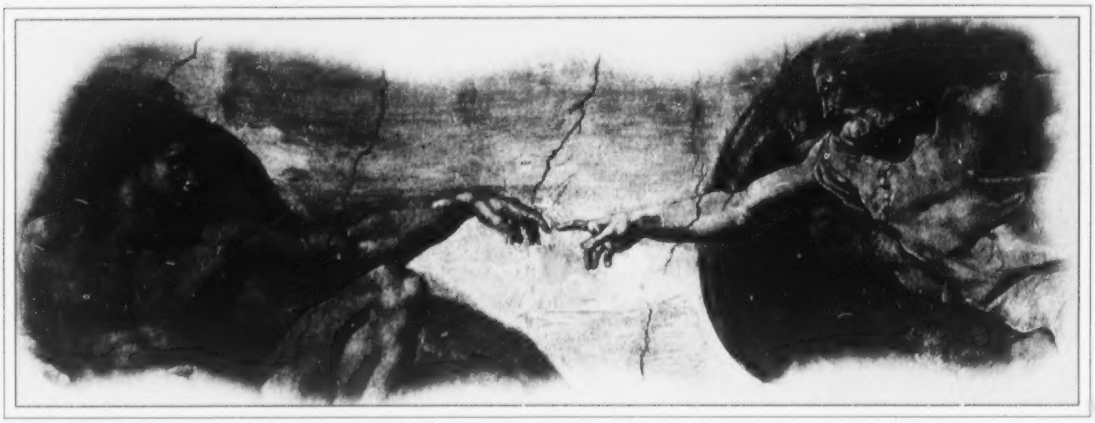
How they work **How they fail** **What's in the future**

Electronic Business

VOLUME 18, NUMBER 6

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

MARCH 30, 1992



Creation of Man, circa 1510 by Michelangelo Buonarroti

COVER STORY

37 How Strategic Alliances work

They can be hard on the nerves, they often don't pay off for years, and they radically upset many of our most hallowed business models—especially the ones based on the "I-win-you-lose" mentality. Why do so many companies line up for such abuse? In some cases, it's the only way to survive

UPFRONT

Business Trends

11 Just how safe a bet is ACE?; Videoconference equipment prices keep sliding; Don't write off a U.S. role in LCD equipment market; Mentor Graphics joins the corporate day-care elite; DEC's Alpha RISC chip faces an uphill battle; Deal watch: M&A activity emerges from the doldrums; Business advice that's worth more than it costs

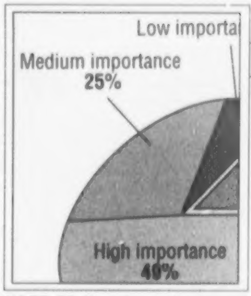
PAGE 11 Just how safe a bet is ACE?

Companies to Watch

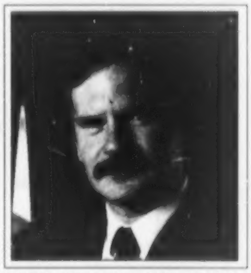
21 Southwest Network Services brings digital data networks to small companies; Exemplar Logic creates logic synthesis tools for FPGAs; Tusk Inc. creates the first all-terrain pen computer

Business Barometer

23 **Semiconductors**
Chip sales to rise 12% this year



PAGE 38 How important are alliances?



PAGE 113 Roland Utenwoldt, Mercedes-Benz North America product planning manager

PAGE 86 How the MEI and Solbourne alliance failed

CEO REPORT

Survey

38 **455 electronics execs say rugged individualism doesn't cut it these days**
Reason: You need teamwork to penetrate new markets, develop products faster, and improve access to technology

Commentary

83 **A new mind-set for electronics executives**
Alliance-building is far more than the latest fad. It has become fundamental to the way electronics companies do business

Strategic alliances

86 **How a good partnership goes bad**
Matsushita pumped $90 million into Solbourne, but poor execution and conflicting goals have prevented the partnership from working as planned

103 **Better together: Big Blue and little Easel**
How a small software company forged a successful alliance with IBM in record-breaking time. Persistence was key

Strategic alliances

113 **Mercedes-Benz and Bose thought they knew everything. Surprise!**
It took six years, and a few culture clashes, for them to develop the "ultimate" sound system for the "ultimate" luxury car

137 **A buyer-supplier alliance that really works**
Conner Peripherals and Compaq Computer show how start-ups can cut their risks while supplying big customers with cutting-edge design

Speakout

145 **Words from on high**
Execs are far from unanimous on what government can do, whether megadeals are worth it, and what's ahead for alliances

Alliances' future

153 **The "Virtual Enterprise": A new success model**
Vertical integration is out. Today's markets require a broad fabric of alliances for effectively managing the entire value chain

DEPARTMENTS

Inside Business

7 We all need partners

My View

161 Customer delight. And more

Company Index

166 Companies covered in this issue

Advertiser Index

167 Advertisers covered in this issue

Viewpoint

168 ACE's critics are right, but. . .

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Assistant Production Editor: Maura A. Baker
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices.
Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

We all need partners

HOW IMPORTANT are strategic alliances for achieving success, and what makes them work?

To a considerable extent, we at ELECTRONIC BUSINESS know the answers to these questions—not just from the results of this year's CEO survey, but also from our strategic alliance with the respected professional services and consulting firm, Ernst & Young. For the past three years, we have jointly produced an annual CEO survey and report.

Senior editor Elizabeth B. Baatz

Let's start with question number one, which really is, "Why do it at all?" The truth is simple. Together, we've produced a more informative, more profitable product than either of us could have done alone.

ELECTRONIC BUSINESS has tremendous reporting resources, diverse industry contacts, and a large body of knowledge about the electronics industry. We're also good at whipping our resources into shape quickly. Ernst & Young has many of these same resources, plus it has the unique insight gained from an abundance of hands-on, problem-solving experience within the industry.

The challenge was—and is—to make those resources work together. That's not always easy. The key was, first, to set a concrete goal that was mutually beneficial. The CEO report in this issue is just that. It gives us both a competitive edge in the markets we serve.

The second key to success was to establish clear and constant communication between partners. Surprisingly, the survey results did not emphasize that, but our case histories did. In our alliance, we each assigned one person to oversee the project and coordinate activities. Senior editor Elizabeth Baatz did that for ELECTRONIC BUSINESS. Exceptional interpersonal skills and a background in economics made her a perfect bridge. Diane Galvin, a marketing manager for the High-Tech Group, was equally terrific as E&Y's link.

In the end, it took roughly one year, from planning to publication, to create the report that you will read inside. The special focus was changed once before deciding on the topic of strategic alliances. Creating, mailing, and interpreting the survey took about four months.

Together, we nearly burned out several fax machines, probably burned out a few staff members as well, and, yes, there were a couple of testy moments. All of that said, however, we think we produced not only a good report, but a better report than we did last year.

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published twice a month, except monthly in December by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer. Frank Sibley, Executive Vice President. Jerry D. Neth, Senior Vice President/Publishing Operations. J.J. Walsh, Senior Vice President/Finance. Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing. Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA. Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140 air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

STRATEGIES

Just how safe a bet is ACE?

IT'S BEEN ALMOST a year since a collective of systems vendors banded together to unveil a dual hardware/software platform they dubbed the Advanced Computing Environment (ACE), and despite mountains of ridicule from competing CISC and RISC camps, the initiative remains intact--albeit somewhat shaken. Potential users and OEMs are still trying to decide if ACE is a viable desktop system architecture that can achieve the market stature its members seek. A key indicator of its success will be the development rate of ACE-compliant software. Even high-powered ACE vendors such as Digital Equipment, Compaq, or Microsoft are not sure how quickly a software base could develop. Vendors outside the ACE collective are more skeptical; they complain that ACE is likely to create more confusion.

ACE members aren't just looking to create a "standard" desktop platform—they're also challenging head-on the establishment that Intel and Sun represent. The 280-odd ACE vendors intend to agree on a basic hardware/software platform, "standard enough" for widespread acceptance, but leaving room for application development by OEMs, software developers, and VARs. ACE, however, is still perceived by the software community as too general yet, ironically, too self-serving.

"They call [ACE] a consortium and expect us to act as a single body," complains Jim Billmeier, Mips Computer VP of software marketing. "The failure of ACE to date is that we have been unable to communicate [ACE objectives] effectively."

Critics charge that too many ACE members are simply using ACE to hedge bets on which architecture will be the next desktop standard. DEC, for example, is also delivering Macintosh systems, Windows-based 80x86 desktops, and its own RISC systems, plus committing to delivery of ACE Advanced RISC Computing systems.

Compaq, a central figure in ACE, may be considering non-ACE operating systems such as Nextstep Unix, which Next Computer is pushing into the Windows-dominated 80x86-based market. Compaq also withdrew a $150 million investment in ACE member Silicon Graphics, which would have allowed Compaq access to SGI's Mips RISC-based graphics-processing technology, catapulting them, in theory, into the Unix/RISC world. The withdrawal is viewed as a blow delivered by Compaq, an 80x86 CISC platform vendor, to Mips RISC.

ACE vendors, meanwhile, are left to fight aggressive anti-ACE marketing tactics on their own. Those tactics manifest themselves head-on, from Sun, or obliquely, from Intel, which will deliver the next 80x86 microprocessor, the 80586. "The real death blow to ACE will be Intel's 80586," says Computerland COO Ed Anderson, who contends there is no compelling need for the huge installed base of 80x86-compatible PC users to move to RISC platforms such as ACE's Mips R4000-based ARC as long as Intel delivers RISC-competitive chips.

Others, such as Opus Systems CEO Jim Katzman, contend ACE's survival depends on Microsoft and its Windows NT operating system. "Going from Windows to NT is a bigger jump than going from DOS to Windows. The rate of independent software development behind NT is really going to determine just how successful NT—and ACE—will be."

The IBM/Apple team also poses a threat if it can deliver RISC-based systems with IBM's RS/6000 processor and the Macintosh-leveraged Pink operating system from its software venture.

—David Webb in San Jose

intel
?
?
SUN
SUN
¿
¿
SUN

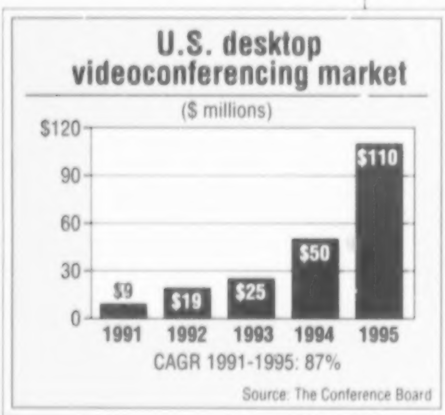
MANAGEMENT TOOLS

Videoconference equipment prices continue downward

THANKS TO a flurry of low-cost product introductions, videoconferencing should soon begin migrating beyond the rarefied world of *Fortune* 500 conference rooms to a broader base of business users. While the equipment is becoming well within reach of small to midsize management budgets, the services needed for face-to-face conferencing remain pricey—sometimes even scarce.

Since January, solutions ranging from video attachments for PCs to scaled-down versions of $50,000-plus systems have debuted. Among them is the Cameo Personal Video System, a video coder/decoder box from Compression Labs that allows Apple Macintosh PCs to support video communications in a screen window. It will cost $1,695 require an ISDN interface of two 64-Kilobit-per-second (Kbps) channels.

Hitachi America plans mid-year shipment of its CA-200 and DP-200 briefcase-size videoconferencing systems. The former, for $13,900, can be attached to any standard TV monitor; the latter, priced at $14,900, includes a built-in 11-inch monitor. They can operate over an ISDN link or over switched 56-Kbps channels.



Source: The Conference Board

Other leading vendors, including PictureTel and VideoTelecom, have also unveiled downscaled products. Lower-priced systems, though, can only go so far in stimulating the market, warns Steve Sazegari, telecom analyst at Dataquest. As important is the widespread availability of high-speed networking services that videoconferencing requires.

ISDN-level services are not universally available, although switched 56-Kbps channels are more widespread. Digital videoconferencing systems need at least 56-Kbps transmission rates for acceptable quality; 112- to 384-Kbps channels are preferred. "The necessary networking services may not be available in some areas, or they may be too expensive for small companies," Sazegari says. Until that changes, low-cost videoconferencing systems won't realize their full market potential.

—Dwight B. Davis

MARKETS

Don't write off a U.S. role in LCD equipment market

SO FAR, THERE'S NO U.S. challenge to the Japanese lead in thin-film transistor liquid crystal displays (TFT LCDs), but the fast-growth market is driving a $5 billion demand for equipment and materials—and that race is still wide open to U.S. players.

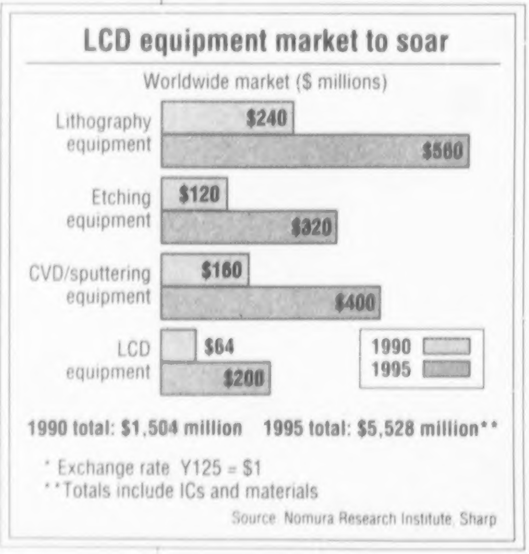
Japanese TFT LCD leaders Sharp and NEC predict a $4 billion market for the displays by 1995; altogether, seven Japanese manufacturers are planning annual capacity of $800 million or more by then. This booming market will support about 30% annual growth in chips, materials, manufacturing, and test equipment, pushing the $1.5 billion market to $5.5 billion by 1995, estimates Nomura Research Institute and Sharp. The biggest opportunity is a potential $1.6 billion market for ICs to drive the displays, and color filters will also approach a $1 billion business. Altogether, materials such as liquid crystals, glass, film, filters, and back lights will amount to some $2.5 billion by mid-decade.

Mass production of the TFT displays is just ramping up this year in Japan, and so far no suppliers have a commanding lead. Japanese LCD makers are eagerly seeking equipment offering higher yields, lower costs, or better displays, such as production machinery made just for LCDs with higher throughput, lower working temperature for glass, cheaper color filters, and lower power drivers.

All the big Japanese names in IC equipment—Dainippon Screen, Nikon, and Canon—are working hard to be dominant players. However, U.S. production and test equipment makers are also making headway into the Japanese market: Applied Materials Japan offers CVD, sputtering, and etching equipment; MRS Technology sells steppers for LCD production; Micrion offers repair systems; and Photon Dynamics, Insystems, KLA Instruments, and Tencor are all talking with LCD makers.

Corning Glass Works, which dominates the market for the specialty non-alkali glass for TFT displays, and Texas Instruments Japan, a big supplier of drivers and assembles modules, are also pushing to become big global players.

—Paula Doe in Japan



* Exchange rate Y125 = $1

**Totals include ICs and materials

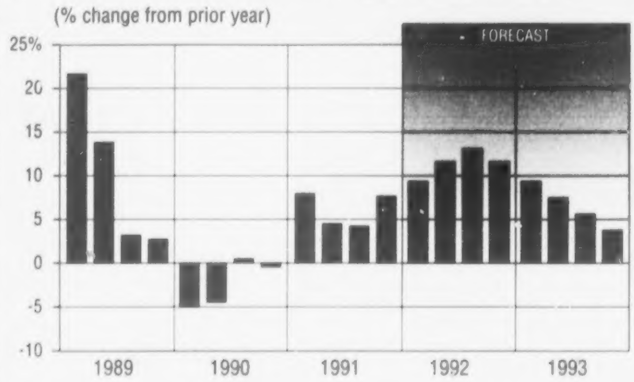
Source: Nomura Research Institute, Sharp

MANAGEMENT

Mentor Graphics joins the corporate day care elite

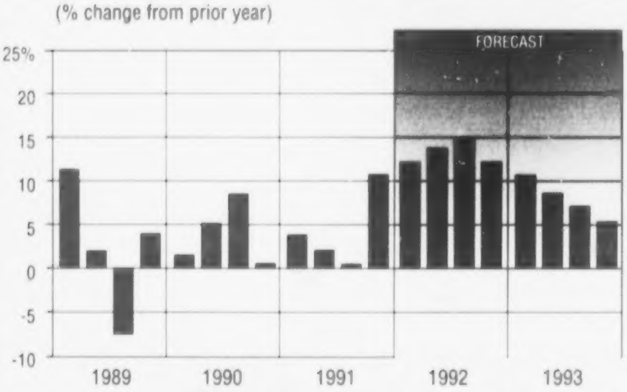
ONE OF MANAGEMENT'S top challenges in the 1990s is to find ways to accommodate a work force that is increasingly made up of two-income families, single par-

Chip sales pop up in the last quarter of '91...



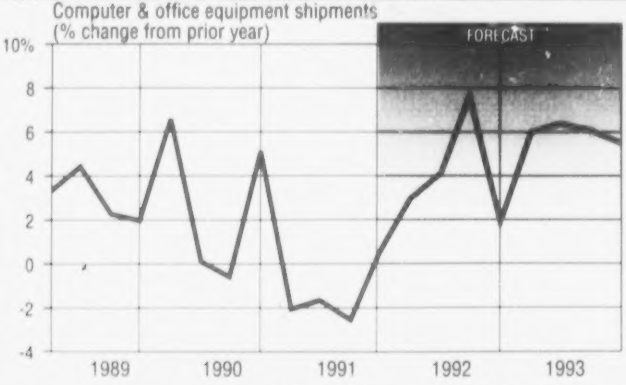
Source: Semiconductor Industry Assn.; forecast: Cahners Economics

...as new orders for semiconductors heat up...



ource: Semiconductor Industry Assn.; forecast: Cahners Economics

...with a little help from 486-driven PC sales



Source: Commerce Department; forecast: Cahners Economics

SEMICONDUCTORS

Chip sales to rise 12% this year

NEWS OF THE chip industry's unfolding recovery has yet to hit the daily headlines, but it is here. Chip sales to the North American market swelled to \$3.89 billion in the final quarter of 1991, up 8.2% over year-ago levels. New orders also surged 11.5% to \$3.98 billion in the last three months of 1991, outracing our forecasted fourth-quarter growth rate of 6%. As a result, the book-to-bill ratio jumped to 1.08 in December.

The reason for the semiconductor industry's good numbers? The better-than-expected sales of the 486 PCs. Overall, U.S. computer and office equipment makers are expected to increase factory shipments by 4.2% this year, after a 1.5% drop in shipments the year before. According to researchers at the Data Analysis Group, sales of PCs are expected to top \$38 billion in 1992 for a 7% annual gain. Sales of laptops, notebooks, and portable computers will be the biggest demand drivers for new chips. Portable computer sales are forecast to capture 11% of the small microcomputer market, and these sales are expected to soar 25% in 1993 to \$5 billion.

It's not just the increase in computer sales that is behind the recent chip recovery. Last year, sales of cellular phones skyrocketed 48%, benefiting many semiconductor manufacturers, especially Motorola. And with only 3% of U.S. households owning a cellular phone, demand for them is expected to to swell. The Electronic Industries Association projects sales will climb 13% in 1992, to 3,500 units.

While the chip recovery in 1992 won't be on par with the big booms of 1988 and 1984, watch for sales to rise 12% this year and 7% next year. Not an explosive recovery, but a recovery nonetheless.

—Julie Handelman-Sagan

How strategic alliances work

Strategic alliances radically upset many of our old business models—especially those that hinge on secrecy and one-upsmanship. They call instead for such unfamiliar qualities as communication and dedication to "win-win" relationships.

Nevertheless, more and more U.S. electronics companies have no choice but to forge alliances with their customers, suppliers, and sometimes even their rivals. Driven by technological complexity, soaring costs, and mounting world competition, companies of every size are being compelled to reach out and link up—to differentiate themselves, to acquire new skills, and even just to survive.

PAGE 38

455 electronics execs say rugged individualism is fading

Here's why. Better penetration of new markets,
faster product development, and improved access to technology

PAGE 83

A new mind-set for electronics executives

Strategic alliances are an essential part of the solutions that deliver total quality,
shorter time-to-market, and more satisfied customers

PAGE 86

How a good partnership goes bad

Matsushita pumped $90 million into Solbourne, but poor execution
and conflicting goals have prevented the partnership from working as planned

PAGE 103

Better together: Big Blue and little Easel

How a small software company forged a successful alliance
with IBM in record-breaking time. Persistence was key

PAGE 113

Mercedes-Benz and Bose thought they knew everything. Surprise!

It took six years for them to develop
the "ultimate" sound system for the "ultimate" luxury car

PAGE 137

A buyer-supplier alliance that really works

Conner Peripherals and Compaq Computer show how startups can
cut their risks while supplying big customers with cutting-edge design

PAGE 145

Words from on high

Execs are far from unanimous on what government can do,
whether megadeals are worth it, and what's ahead for alliances

PAGE 153

The "Virtual Enterprise": Your new model for success

Vertical integration is out. Today's markets require
a broad fabric of alliances for managing the entire value chain

455 electronics execs say rugged individualism is fading

Here's why. Better penetration of new markets, faster product development, and improved access to technology

By Stephen E. Almassy and E. B. Baatz

During the past few years, strategic alliances have transformed the electronics industry. Once perceived as an option reserved only for the corporate giants, teaming up has become the spark that has ignited the imaginations of companies of every size—from start-ups to multinationals—and in every industry segment—from software to aerospace and defense electronics. The go-it-alone strategy no longer seems to be a viable alternative.

The alliance concept is hardly new, of course. What is new is the fervor and intensity with which electronics companies are putting those ideas to work. Due to the maturation of several trends of the '80s—intensified foreign competition, shortened product cycles, soaring capital investment costs, and the ever-growing demand for new technologies—alliances are becoming an imperative for the '90s.

In this third annual CEO survey, conducted by ELECTRONIC BUSINESS *and the professional services firm of Ernst & Young, 455 industry leaders reflect on the pitfalls and opportunities inherent in strategic alliances. They offer some revealing insights into what they have learned about alliances, lessons that could teach your company how to achieve its highest objectives.*

Who relies most on alliances?

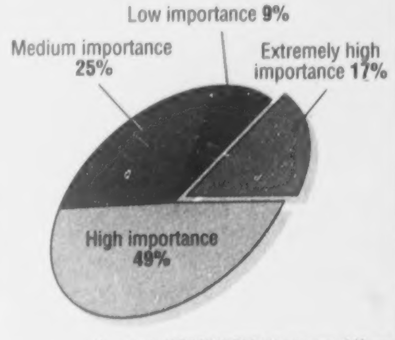
(% ranking importance of alliances as extremely high or high in their strategic plan)

Software	79%
Computers and peripherals	73
Medical electronics and other	71
Industrial electronics	64
Semiconductors and components	64
Voice and data communications	52
Aerospace and defense electronics	52

Source: ELECTRONIC BUSINESS/Ernst & Young

How important are alliances?

(% ranking importance of alliances in their strategic plan)



Source: ELECTRONIC BUSINESS/Ernst & Young

MORE THAN 85% of electronics CEOs we surveyed are involved in alliances, and two-thirds say those alliances figure prominently in their strategic plans. Companies that spend heavily on research and development are more likely to form marketing, joint product development, and technology licensing alliances. The biggest reason: Sizable R&D commitments leave fewer resources for other activities, driving some companies to collaborate as a means to exploit their technologies. Software companies rely on alliances the most.

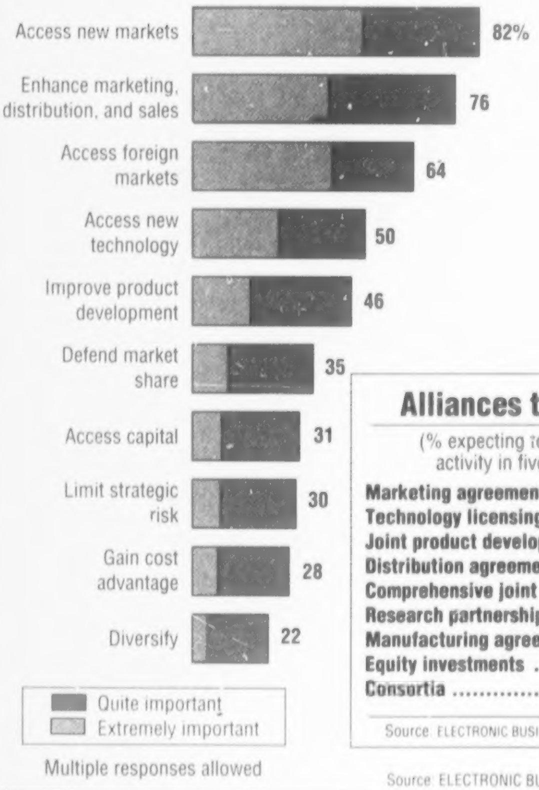
Although alliances between large multinationals grab most of the headlines, smaller companies are more likely to consider alliances critical to their success. For many smaller companies, an alliance with a larger company can lead to faster acceptance of a new technology. The flip side, however, is that an unsuccessful alliance can be far more damaging to the smaller company. ☐

SINCE MANY OF the goals of an alliance are not quantitative in nature, calculating success is often difficult. A change in market position, however, is something CEOs can point to when measuring success. When we asked executives if their most important alliances have improved their companies' market positions, most say that they have experienced an improvement. In fact, 17% indicate that they have achieved a *vast* improvement in market position through key alliances. Executives at small companies are naturally able to see more dramatic shifts because of their relatively small market share bases. They are three times as likely as CEOs at top-tier companies—those with more than $300 million in revenue—to report substantial improvements.

When executives are asked to rank the importance of strategic alliances to such factors as product quality and customer service, about 15% contend alliances are critical to their companies' success, and more than 40% of those respondents claim that alliances have led to vast improvements in their market positions. Among those companies that consider alliances less important to their companies' success, however, only 12% report vast improvements in market position via alliances. ▼

Why do electronics companies team up?

(% ranking most important reasons for alliances)



Multiple responses allowed

Source: ELECTRONIC BUSINESS/Ernst & Young

Alliances targeted

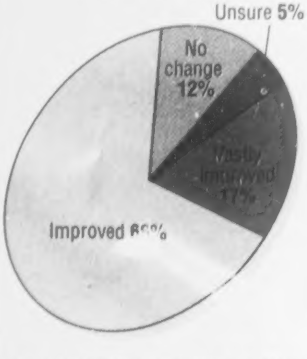
(% expecting to increase activity in five years)

Marketing agreements	81%
Technology licensing	77
Joint product development	77
Distribution agreements	72
Comprehensive joint ventures	58
Research partnerships	58
Manufacturing agreements	58
Equity investments	54
Consortia	36

Source: ELECTRONIC BUSINESS/Ernst & Young

Can CEOs measure success?

(% ranking change in market position due to alliances)



Source: ELECTRONIC BUSINESS/Ernst & Young

THE STRATEGIC ALLIANCE can be a powerful tool throughout a company's value chain—from the supply base to the customer—and can be used to differentiate its products and services. Indeed, value-chain improvements, especially at the customer end, have been a key driver in the alliance trend among electronics companies. Nearly 80% of the respondents claim that their alliances are driven primarily by the need to access new markets and to enhance marketing, distribution, and sales operations; 81% predict an increase in the number of marketing alliances over the next five years. Alliances are crucial earlier in the value chain as well. More than 75% of executives also anticipate an increase in both technology licensing and joint product development agreements.

The forces that lead companies to team up differ slightly by industry segment. In the voice and data communications industry, for instance, nearly half of the CEOs cite prevention of market-share loss as a driver of their alliance strategies. These CEOs also rank access to new markets higher than other industry executives. Semiconductor and component leaders, however, focus more on access to new technologies and improved product development as a motivating force for strategic alliances. ☐

Strategic alliances key to reducing time

(% ranking extremely important reasons for alliances)

	Time-sensitive executives	All other executives
Access new markets	55%	45%
Enhance marketing, distribution, and sales	50	33
Access new technology	44	15
Improve product development	24	11
Defend market share	20	8
Gain cost advantage	13	6

Source: ELECTRONIC BUSINESS/Ernst & Young

EXECUTIVES WHO ARE most constrained by the time required to bring a product to market rely on strategic alliances more than those CEOs whose businesses or products are less time-dependent. Time-sensitive CEOs not only pursue significantly more alliances and more types of alliances, but they also report higher levels of success than other executives. Their companies appear to be more active than others in alliances all across the value chain, but they are especially so in the voice and data communication industry. ◄ ☐

THE CEO or COO usually handles the early stages of alliances, such as setting goals, selecting partners, and negotiating terms—especially in small companies. The key to successful implementation, however, is the alliance manager—usually a functional vice president. More than 85% of companies with alliances do not have dedicated alliance managers. ►

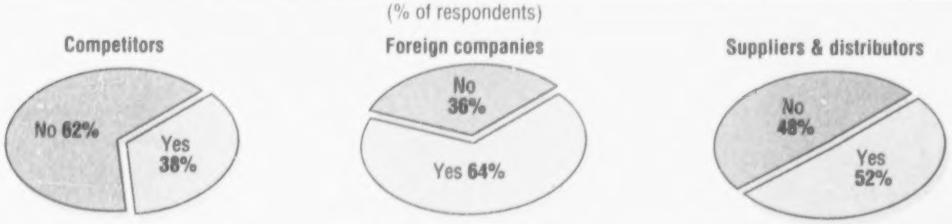
Who drives the alliances?

(% indicating who has primary responsibility by task)

	CEO	Functional VP	Alliance manager	Others
Negotiate alliance	60%	16%	5%	19%
Manage implementation	23	42	12	23
Analyze alliance goals	57	14	6	23

Source: ELECTRONIC BUSINESS/Ernst & Young

Who do U.S. electronics companies choose as partners?



Source: ELECTRONIC BUSINESS/Ernst & Young

MORE THAN ONE in three companies surveyed say they have established or plan to establish alliances with competitors. The computer and peripherals industry, with its recent megadeals and start-up of the ACE (Advanced Computing Environment) consortium, leads the trend: More than 45% of computer and peripherals companies report alliances with a rival. Two-thirds of all top-tier companies have also teamed up with the competition.

Partnering with a foreign company has also become a popular strategic move for 64% of the companies in the survey, with all industries about equally active. Among those who rate alliances as a critical success factor, about a third have struck deals with Japanese companies.

It's no wonder foreign alliances are hot. Industry leaders, especially in the aerospace and defense electronics and the semiconductor and components industries, say access to foreign markets will become much more important during the next five years. Slowing domestic growth has meant increasingly aggressive global strategies. Perhaps these industries are now eyeing global opportunities that, in the past, were either difficult to pursue or not as attractive as other alternatives.

Only half of the CEOs say they have a strategic alliance with a distributor or a supplier. Given the trend to single-source suppliers, this finding may seem low, but executives seem simply to view their supplier alliances as a given today. ☐

What makes strategic alliances succeed or fail?

WHAT DO TOP EXECUTIVES see as the most important factors in planning and structuring their alliances? The selection of an alliance partner, according to an overwhelming 75% of our CEOs. The selection process, in fact, consumes significant corporate resources and can last a year or more. The second most important planning factor is a clear understanding of each partner's role; six out of 10 executives in the software segment rate the need for defining roles as extremely important, more so than in any other industry. Developing close ties among senior management, on the other hand, is considered to be extremely important by only 27% of electronics companies.

When it comes to managing and implementing an alliance, only one factor is rated as extremely important by more than half of all CEOs: commitment by senior management. Having a clear understanding of roles, considered by 49% of all executives to be important in the planning stages, is thought to be somewhat less crucial during implementation. Also interesting is that thorough planning—a basic business principle—is rated as important by only 30% of the respondents. The probable reason is that many alliances are struck without hard objectives; instead, they are exploratory in nature, and so begin without a detailed business plan.

Factors that contribute to the success of any relationship, such as good communication, frequent feedback, and alignment of corporate cultures also rate surprisingly low. Although there is much anecdotal evidence that these people-oriented issues are vital in successful alliance management, the survey shows that U.S. electronics executives are unconcerned about, or perhaps are not involved in, alliances that require much cooperation and teamwork.

Alliances do fail, of course. CEOs across all industries and company sizes say that one factor stands out most when they consider their alliance failures: overly optimistic expectations. When goals that exceed the capabilities of the alliance team are set, alliance managers shoulder more pressures and face more obstacles. Approximately half of the CEOs also point to poor communication and lack of shared benefits as important reasons for failure during the implementation stage. The survey revealed a mismatch between top-tier and developing companies. Top-tier companies are twice as likely as developing companies to point to a misunderstanding of principles as an important reason for an alliance failure. Developing companies are twice as likely to say the other party's lack of financial commitment was a critical failure factor. ☐

Planning: choose wisely

(% ranking important tasks in planning successful alliances)

Selection of partner	75%
Clear understanding of roles	49
Clear definition of objectives	39
Communication/relationship building	36
Close ties among senior management	27
Clear time line for payback	14

Multiple responses allowed

Source: ELECTRONIC BUSINESS/Ernst & Young

Implementation: talk to top

(% ranking important tasks in managing successful alliances)

Senior management commitment	73%
Communication between partners	48
Clear understanding of roles	44
Thorough planning	30
Frequent performance feedback	16
Attention to day-to-day problems	16
Sharing of resources and risk	15
Alignment of cultures	11
Previous alliance experience	6
Integration of information systems	2

Multiple responses allowed

Source: ELECTRONIC BUSINESS/Ernst & Young

Beware: false expectations

(% ranking important reasons for failed alliances)

Overly optimistic expectations	73%
Poor communication	54
Lack of shared benefits	49
Slow results or payback	42
Lack of financial commitment	32
Misunderstanding operating principles	31
Cultural mismatch	28
Lack of alliance experience	20

Multiple responses allowed

Source: ELECTRONIC BUSINESS/Ernst & Young

Benchmark '92:

The CEO's agenda this year

Ever since we introduced the ELECTRONIC BUSINESS/Ernst & Young executive survey three years ago, our mission has been to add unique insights into the questions uppermost in the minds of U.S. electronics industry CEOs: What are the most important ingredients for competitive success? Which innovative technologies offer U.S. companies their best opportunities? What are the most troubling socio-economic issues affecting profits this year? What do executives want from government to help their companies?

The answers reveal important, sometimes shifting trends within the industry. For example, capital availability is no longer the major concern it was two years ago. And despite the recession, CEOs are still as unwilling as they were last year to endorse an industrial policy.

What are the competitive success factors?

(% ranking important factors critical to their competitiveness)	1992	Ranking 1991*	1992	1996**
Product quality	67%	3	1	1
Customer service	65	4	2	2
New product development	52	NA	3	3
Technology innovation	50	1	4	4
Attract and retain key people	45	2	5	6
Time to market	42	7	6	5
Capital availability	32	5	7	10
Organizational excellence	32	6	8	7
Proprietary intellectual property	24	8	9	9
Access to foreign markets	22	9	10	8
Supplier relationships	20	10	11	11
Strategic alliances	15	NA	12	12

Multiple responses allowed

* Ranking from 1991 CEO survey **CEOs' anticipated ranking

NA = not available

Source: ELECTRONIC BUSINESS/Ernst & Young

THIS YEAR'S survey reflects subtle but important changes in how CEOs view the ingredients of competitive success. Last year, technology innovation and the ability to attract and keep key people ranked highest in terms of what was considered critical to a company's competitiveness. This year, however, CEOs ranked product quality and customer service as the most important considerations—the result, probably, of what some see as a worldwide obsession with quality and service as competitive tools. Nor are these factors likely to abate soon: Nearly three-quarters of all CEOs expect product quality and customer service to remain critical differentiators five years down the road. ☐

THE LONG-TERM success of any electronics company clearly is tied to the CEO's ability to identify and capitalize on innovation opportunities. Approximately 80% of executives believe the most promising opportunities lie in the following technologies: advanced telecommunications, advanced semiconductors, high-performance computing, and imaging.

This year, CEOs rated advanced telecommunications highest. The telecom industry's excitement about personal communication networks, wireless voice and data products, and new video services has made other industry segments more aware of the near-term opportunities these technologies offer. ➤

What are the most promising technologies?

(% ranking promising technologies for electronics innovation)	1992	Ranking 1991*	1992
Advanced telecommunications	84%	2	1
Advanced semiconductors	83	1	2
High-performance computing	79	4	3
Imaging technology	78	5	4
Advanced materials	73	3	5
Personal computing **	71	NA	6
Medical electronics	70	7	7
High-density data storage	69	6	8
Multimedia	69	NA	9
Optoelectronics	63	9	10
Flexible computer integrated manufacturing	59	10	11
Superconductors	52	8	12

Multiple responses allowed

* Ranking from 1991 CEO survey

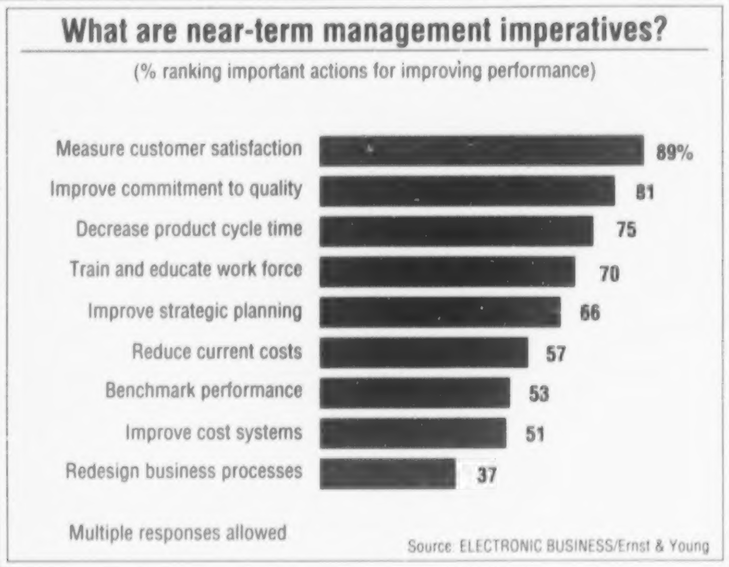
**Pen-based computers, wireless laptops, etc.

NA = not available

Source: ELECTRONIC BUSINESS/Ernst & Young

What are near-term management imperatives?

(% ranking important actions for improving performance)



Multiple responses allowed

Source: ELECTRONIC BUSINESS/Ernst & Young

DEVELOPING PRODUCTS and services that ensure customer satisfaction has become a top priority throughout the electronics industry. In findings consistent with last year's survey, CEOs emphasize that creating an effective way to measure customer satisfaction is a vital element in improving company performance; almost nine in 10 CEOs rated this near-term management action item as most important.

At least 75% of the executives also rate improving their commitment to quality and decreasing their product cycle times as important to improving performance. Reducing current costs and improving cost systems does not rate highly among the management imperatives. Perhaps CEOs view costs, as they should, as part of their commitment to improving ◀ quality and reducing cycle times.

What's killing profits?

(% ranking problems that affect profits the most today)

Recession	76%
Lack of technical talent	55
Federal budget deficit	51
Interest rates	41
Fluctuation in the dollar	40
Federal trade deficit	36

Last year's top three:
1. Recession
2. Federal budget deficit
3. War in the Middle East

Source: ELECTRONIC BUSINESS/Ernst & Young

THREE OUT OF four CEOs cite the recession as the most significant socio-economic influence on their companies' profits this year. The lack of technical talent, considered second only to the economy's woes, is an issue that was hotly debated in last year's CEO report; this year's findings confirm how serious a problem scarce technical talent has truly become. Despite the fact that the federal budget deficit has ballooned to record-breaking high levels, only about half of CEOs surveyed rated it as a serious drag on their profits. ☐

AS IN PAST CEO surveys, there seems to be no industry-wide consensus on what government should do to support the industry, except for making R&D tax credits permanent and cutting capital gains taxes. These two initiatives, which stalled in Congress last year, have become top-drawer policy proposals for the 1992 elections.

More than a third of the respondents also want government to strengthen intellectual property laws, a significantly larger number than were calling for this action a year ago. CEOs of software companies are particularly concerned about intellectual property; nearly half want government to strengthen the laws. Interestingly, the survey shows that most CEOs are cool to the idea of an electronics industrial policy. And relatively few executives call for the relaxation of antitrust laws. ▼

What should Uncle Sam do now?

(% ranking important government actions)

	1992	1991*
Make R&D tax credits permanent	61%	66%
Index capital gains tax to zero	57	48
Strengthen intellectual property laws	36	26
Toughen trade negotiating stance	33	35
Increase government spending on technology	22	21
Establish electronics industrial policy	22	NA
Create technology venture capital entity	21	25
Relax antitrust laws	17	13
Create U.S. institute of trade similar to MITI	15	18
Toughen position on foreign direct investment	12	NA
Reduce frequency of reports to SEC	9	NA

Multiple responses allowed
NA = not available

* Ranking from 1991 CEO survey

Source: ELECTRONIC BUSINESS/Ernst & Young

Methodology snapshot:

How we did it and who responded

Last fall, *ELECTRONIC BUSINESS* and Ernst & Young mailed an eight-page survey to a sample of chief executives, presidents, and chairmen at 3,250 U.S. electronics companies. Responses were received from 455 companies for a 14% response rate. By region, 40% of responses were from Silicon Valley, 15% from Southern California, and 14% from New England and New York. Demographic data on the CEOs surveyed is presented in the tables below.

We want to acknowledge Ernst & Young's high-tech industry and marketing group and management consultant Jon Glasco of Technology Planning Systems in Oakland, Calif.

About Stephen E. Almassy and Ernst & Young

Stephen E. Almassy, national director of Ernst & Young's Electronics Industry Services, assists high-tech companies worldwide with auditing, financial consulting, public offerings, mergers, acquisitions, and strategic alliances. Ernst & Young is one of the largest professional services firms in the U.S. and has 66,000 employees in more than 100 countries. For high-tech assistance, call Ernst & Young at (408) 947-6676. ☐

DEMOGRAPHICS

Demographics by industry segment and company size

Segment	Number of companies	% of respondents	% of revenue	% of employees	1991/90 growth* revenue	1991/90 growth* employees	Industry segment definitions (% of segment respondents)
Industrial electronics	84	19%	5%	8%	4%	1%	Test & measurement 54%; semi manufacturing equip. 26%; factory systems and other 20%
Computers & peripherals	62	14	22	29	13	-1	Peripherals 57%; computers 37%; other 6%
Semiconductors & components	82	18	8	14	-5	1	Semiconductors 24%; passive components 55%; printed circuit boards 7%; other 14%
Software	81	18	4	5	12	5	Software 66%; CAE/CAD/CASE/CAD/CIM 22%; systems integration 8%; other 4%
Voice & data communications	50	11	3	4	-1	4	Telecom 36%; datacom 46%; other 18%
Medical electronics & other	43	9	17	12	11	1	Medical electronics 35%; consumer electronics 16%; office equipment 5%; other 44%
Aerospace & defense electronics	53	11	41	28	1	-10	Commercial aerospace 10%; military aerospace 25%; military telecom 8%; defense electronics 46%; other 11%

Company size	Number of companies	% of respondents	% of revenue	% of employees	1991/90 growth* revenue	1991/90 growth* employees	Company size definitions	(Annual revenue, $ millions)
Top-tier	37	8%	87%	73%	5%	-5%	Top-tier	more than $300
Large	42	9	6	13	-5	7	Large	$100 to $300
Midsize	84	19	4	7	7	4	Midsize	$25 to $100
Small	184	40	2	4	12	5	Small	$5 to $25
Developing	108	24	1	3	-35	-6	Developing	less than $5

* Not adjusted for inflation

Source: ELECTRONIC BUSINESS/Ernst & Young

COMMENTARY

A new mind-set for electronics executives

Cindy Charles

IF THERE ARE ANY MANAGERS LEFT who still expect the current strategic-alliance "phase" to subside, this year's survey of chief executives should serve as a wake-up call. It also should sound a call to action for the entire industry. U.S. executives must become world-class initiators and managers of strategic alliances if their companies are to compete successfully in the 1990s.

Alliance building is now fundamental to the way U.S. electronics companies conduct business. In every area of operations—from technology and product development to manufacturing and marketing—we are witnessing an explosive increase in competition for strategic alliances. As the survey shows, some eight out of 10 electronics companies now have alliances, and most CEOs are planning or negotiating new ones. The quality of business alliances now plays an essential role in how well most U.S. companies serve their customers in the global marketplace.

U.S. executives, in general, claim to be gaining significant advantages from their alliances, but they also see room for improvement: While eight out of 10 CEOs say they have enhanced their companies' market positions through alliances, very few claim to have scored "vast" improvements. CEOs also express frustration with the return on some of their alliances, including the time it takes to make the partnerships successful.

What's required is a new mind-set that will allow U.S. companies to maximize their alliances in the context of meeting customers' needs in the global marketplace. In recent years, U.S. companies committed themselves to achieving total quality throughout their own organizations. For the rest of the 1990s, the challenge will be to extend enterprise-wide excellence concepts beyond corporate boundaries.

U.S. companies have to relearn and rethink the way they manage. A new openness needs to be established in how they communicate, share information, and plan their strategies with business allies. U.S. companies will need to learn the art of cooperation and team building, even with competitors. At the same time, our global alliances will need to be grounded in a better understanding of cultural diversity. Most of all, the ability to manage across functions—an approach that many U.S. executives have yet to master in their own companies—is now critical to competitive advantage.

But it isn't up to private enterprise alone. Government, education, and industry all need to play a role. U.S. business schools need to devote more resources to understanding alliance management processes, from contract negotiations to establishing effective communications. They also need to graduate managers with a new set of competencies, including foreign languages and other communications skills. Government must reassess tax and anti-trust laws to facilitate global cooperative ventures.

The rules of the game have changed forever. U.S. industry needs to move quickly to form the world-class partnerships needed to compete.

—Stephen E. Almassy, national director of Ernst & Young's Electronics Industry Services

How a good partnership goes bad

Matsushita has pumped $90 million into Solbourne, but poor execution and conflicting goals have prevented the partnership from working as planned

By Peter Burrows

This is a story about an alliance that failed. It's not about villains, although there is plenty of blame to go around. It is about too many bad business judgments, a few conflicting goals, inconsistent communication, and confused allegiances. Taken together, these problems helped doom what at the start looked to be a sure success.

The partners involved are $46 billion Matsushita Electric Industries Co. (MEI) of Osaka, Japan's largest electronics conglomerate, and start-up Solbourne Computer Inc. of Longmont, Colo., which had grown to about $60 million in revenues with 350 employees before a major downsizing last January.

When MEI purchased a 52% share in the workstation maker in 1987, the synergies seemed clear. Solbourne needed money and MEI's manufacturing expertise; Solbourne was an early licensee of Sun Microsystems Inc.'s Scalable Processor Architecture (SPARC) and had lofty goals for the fast-emerging workstation market. MEI also wanted a presence in that market, as well as access to the underlying RISC computing technology for use in future generations of gadgets and appliances for the "home of the future."

Unfortunately, it hasn't worked out that way. After launching an ambitious plan in 1988 to become the Compaq of the workstation world by cloning Sun's popular SPARC computers, Solbourne announced in January that it was bailing out of the workstation world to focus on the niche for Unix-servers. It dismissed one-third of its employees, including most of its management staff, in the process. Some employees say what is left is little more than a U.S. R&D arm for MEI, and the shell of a once-proud high-technology company that has been decimated by too many months of internal strife (see "Beware of confused allegiances," page TK).

MEI, on the other hand, seems to have met most of its key goals, say both MEI and Solbourne executives. While its $90 million-plus investment was a steep price to pay, MEI has obtained its own RISC-microprocessor, world-class design capabilities, and a license to build competitive workstations for its own use. It has even introduced its own Solbourne-inspired workstation for sale in the Japanese market and is reportedly developing a range of SPARC-based laptop and notebook computers as well as high-definition televisions and other consumer items equipped with its new SPARC technology. "We gave them technology and we trained them to use it, and now they're doing everything you'd think a big Japanese company would do," says one former Solbourne employee.

Big money and good intentions aren't enough

Majority shareholder makes a comprehensive joint venture in 1987

Solbourne

Industry	Unix workstations and servers
1991 revenue	$40 million*
Alliance goals	- Funding - Manufacturing expertise - Distribution in Japan

Matsushita

Industry	Consumer and industrial electronics, components
1991 revenue	$46,000 million
Alliance goals	- RISC technology - Return on investment

Results Matsushita invested $90 million in Solbourne and got RISC technology in return. However, Solbourne has not achieved most of its alliance goals and has since left the workstation market

*Estimate Source: ELECTRONIC BUSINESS

Illustrations by Christopher Bing

Maybe. Japan bashing is all the rage these days, but whether MEI meant to suck out Solbourne's technology without regard for the U.S. start-up's long-term health is still not settled. Most observers don't think so, and executives from both camps insist that their partnership is a model of long-term commitment and cooperation—if not results. What's undeniable is that, while MEI has achieved many of its stated goals, Solbourne has not; it still faces a struggle to survive with an unwelcome Plan B.

Why did Plan A fail? Solbourne executives, past and present, insistently refuse to blame MEI. "Matsushita was a great partner," says Dan Wilkie, who was Solbourne president and COO until he resigned during the January restructuring. "It invested close to $100 million in Solbourne, but it left the day-to-day management to us." Solbourne founder and CEO Douglas B. MacGregor agrees. "If anyone hasn't delivered, it's us."

To some extent, MacGregor appears to be right. He and Wilkie failed to predict the predatory pricing practices of Sun and a flood of rivals such as Hewlett-Packard and IBM. Instead, they built up the company on the assumption that it would soon be a $1 billion operation. They had seven layers of management for just 350 people. The running joke among engineers was "we have more vice presidents than products."

OTHER PROBLEMS included a bull-headed insistence on developing proprietary technology, as well as poor project management. At one point during the midst of developing their first workstation, a personnel reshuffling left *zero* designers working on the core microprocessor for weeks, admits MacGregor. Basic management mistakes such as these contributed heavily to the delays and performance glitches that subsequently hobbled the company.

Conversely, problems with the partnership compounded MacGregor's management errors and made Solbourne's success nearly impossible. For starters, the deal seemed crafted more to protect MEI's desire for access to Solbourne technology than to guarantee Solbourne's needs for responsive support. For example, Solbourne met its contractual agreement to involve MEI engineers in all development projects—about 15 MEI engineers have usually been on-site in Longmont—and it delivered a range of technology specified in the partnership agreement. Matsushita, on the other hand, has failed to deliver on its exclusive rights to distribute Solbourne products in Japan, and it did not always provide manufacturing services to meet Solbourne's needs in terms of cost, performance, or timeliness.

Until MacGregor made a trip to Japan in mid-1990 to demand the promised manufacturing support, MEI consistently did not match the price and response time promised by local U.S. contract houses, sources say. "I really expected more cooperation from them," says one current Solbourne engineer who, on the whole, gives MEI high marks. "I couldn't understand why their R&D division would give us so much money only to have manufacturing try to earn it back."

Another critical example of conflicting expectations and capabilities occurred during the development of the cutting-edge microprocessor for Solbourne's first workstation, the S4000. In mid-1990, a design was in place that would have given this machine a 25% speed advantage and a six-month headstart over Sun's then-unreleased SparcStation II. However, months after committing to build the device, MEI admitted it couldn't produce the part at the agreed-upon performance, in the agreed upon timetable, or at the agreed-upon price.

James Cook

Solbourne CEO MacGregor takes most of the heat for Solbourne's failures

In the end, the MPU project took three and one-half years instead of two, sources say, and the S4000 turned out to be a clone rather than a breakthrough product. It was introduced just one month before the SparcStation II, and its system speed of 33 megahertz was roughly the same as Sun's—not the hoped-for 40 MHz.

"We were a few MIPS short and a few months late from a viable fight with Sun," says former director of development engineering Mho Salim, who was laid off in January.

Salim and MacGregor say that internal engineering gaffs were more responsible for the delay than MEI's unresponsiveness, but many others disagree. These critics argue that MEI held undue and counter-productive sway over Solbourne's product direction. "We knew we were going to be a year too late before we finished that processor, and we tried to convince our management to go to an off-the-shelf version" in an effort to extend the time-to-market lead over Sun, says a former engineering manager. "MEI wouldn't

Why a good partnership fell short

Lopsided organizational links

Solbourne design engineers worked with Matsushita researchers rather than a production unit. This helped Matsushita transfer technology but led to delays and production disappointments for Solbourne

False expections

Solbourne overestimated Matsushita's manufacturing and distribution prowess, while Matsushita had unrealistic notions about Solbourne's design expertise. In the end, both were brought back to earth

Inconsistent communication

Matsushita provided little input on business issues so as to ensure Solbourne's autonomy, but some say the lack of interchange led Solbourne management to stick to the letter of the partnership without adapting to changing market realities

Manufacturing inflexibility

Matsushita made many exceptions to the "Matsushita Way" for Solbourne's sake. Still, Solbourne should have relied more heavily on smaller, more responsive third-party manufacturers after Matsushita proved unwieldy in some cases

Rampant rumor mill

One camp within Solbourne believes Matsushita is steering Solbourne to become its own U.S.-based research lab. Others say Solbourne management has abused Matsushita's largess in a greedy rush to go public. The end result was mixed allegiances, cynicism, and unnecessary turnover hear of it. It wanted that MPU."

It is clear that poor communication between Solbourne management and its engineers made matters worse. Despite warnings from engineering, MacGregor refused to discontinue development of the chip, and even fired engineering vice president Bob Thompson for arguing the case too vehemently. MacGregor concedes now that hindsight has vindicated Thompson's view, but "we needed to go for broke, because I knew a me-too product wasn't going to do us much good against larger rivals with economies of scale on their side." He steadfastly denies that MEI was behind the decision to continue development of the proprietary chip.

Senior coordinator Kaz Minami, MEI's top full-time official at Longmont, agrees. "MEI was not consulted until the last moment about the MPU being inadequate or too late. We were told that, although there were problems, management would be able to work them out."

Management did not work them out, however, and many former Solbourne employees accuse MacGregor—a graduate of Osaka University who is considered to have a bright future within MEI—of slavishly following the letter of the contract without testing its flexibility.

"Of all the U.S./Japanese alliances I know, Solbourne had the most autonomy," says a former Solbourne chip designer. "Unfortunately, Solbourne's management didn't take advantage of that autonomy." In one case, MacGregor nixed a proposed two-phase production plan that would have let manufacturing engineers use less expensive, more responsive local contract houses for prototyping and MEI for the volume runs that are their forte.

MacGregor dismisses such charges as Monday morning quarterbacking by people with no access to boardroom thinking: "I never knowingly put the partnership ahead of Solbourne's best interests."

ANOTHER STUMBLING block was the reporting structure between Solbourne's design engineers and MEI. Instead of working directly with a manufacturing unit, Solbourne's engineers worked with MEI's R&D department—which was seemingly more interested in learning about Solbourne's technology than in getting its products to market on time. One result was difficulty in moving requests for production out of MEI's R&D and into the proper MEI manufacturing operation. Even when this was done, front-line managers showed little inclination to interrupt one of MEI's mega-volume production runs to make room for a high-tech, low-volume order from a far-off subsidiary.

"I went over there seven times one year to try and get them to make the necessary investments [to be able to build Solbourne's first workstation], but I could never find anyone willing to stick their neck out and take any responsibility," says a former manufacturing engineer. "Urgency was not their priority, but it was our lifeblood."

Tension between engineering and manufacturing widened the gap in the partnership

Tension between engineering and manufacturing is a fact of life in many companies, but cultural misperceptions widened the gap in this partnership. Given the Japanese's reputation for being the "gods of manufacturing," Solbourne engineers thought MEI would easily be able to build chips and boards that were on the cutting edge of technology. The microprocessor, for example, was the world's first RISC-system on a chip, says Nick Mati, a Solbourne co-founder who has since left. "Looking back, we were far too optimistic about Matsushita's processing capabilities."

Similarly, Solbourne management mistakenly thought MEI would respond to production demands like a U.S. manufacturer. "They are far more process-oriented," says one engineer. "You can't just pay more to get the board built, because they won't alter their build rate for fear of bringing down the quality. Their strength is in mass production, not prototype build."

Conversely, MEI made false gods of Solbourne's designers. "We told them that you can't produce a chip like that in just four months, but they didn't understand," says a former Solbourne designer. "They thought we were such great engineers that the product would be close to perfect the first time through. We knew that wasn't the case." In the end, it took much longer to move the project from engineering to production, and both America's design expertise and Japan's manufacturing skills lost some luster in the eyes of their counterparts.

Solbourne also overlooked a key fact in granting MEI exclusive rights to distribute Solbourne products in Japan: MEI hasn't been a major presence in the computer business since 1964. Despite its vaunted distribution channels for Panasonic and National brand-name consumer goods, MEI has sold fewer than 1,000 Solbourne computers in Japan since 1987.

"I pressed them very, very hard to be more aggressive, but it is not like selling VCRs," says recently resigned vice president of marketing and sales Marc Stevenson. He had targeted $10 million in sales to Japan for 1991, but he says MEI moved less than $3 million. A restructuring of the channel has improved sales over the past six months, he says.

Stevenson, as with many other Solbourne executives, blames such partnering problems on poor execution and diverging business practices rather than on bad intent. Critics within the company paint a darker, more conspiratorial picture of MEI's behavior. Many former employees are convinced that MEI deliberately steered Solbourne's technical direction with little regard for its long-term health. "MEI wanted to keep us at a simmer, and it didn't understand that, in this game, you either go up or down," says one former engineering manager. "If it just wanted an R&D arm, we shouldn't have been selling any product."

The proof, these critics say, is in MEI's highly selective interest in

Solbourne assets. MEI adopted a do-as-you-wish approach to daily business issues, but it retained a tight grip over technology issues and engineering resources. Armed with daily communiques from Minami and the authority that comes with four of seven board seats, executives in Osaka moved fast whenever MEI's interests were threatened, some former Solbourne employees allege. Case in point: When a wave of resignations occurred in the engineering department after a lay-off in December of 1990, some of those who remained received repeated pep talks and promises of career advancement from MEI. This included a New Year's Eve off-site meeting with MEI officials designed to lay out technical directions and, in part, to assure engineers of their future with Solbourne.

Even when MacGregor was down to just a few months of financing and went to Japan to suggest potential restructuring schemes, MEI insisted only that it be able to review and veto any scenario involving the firing of engineers. In the end, MEI agreed to buy all of Solbourne's workstation inventory, and MacGregor opted for a 121-person lay-off that included only a handful of engineers.

MacGregor says it was always his plan to redirect the company to its strength in product development, but some question whether he came to the decision unilaterally. Dan Ganousis, an ASIC design manager who resigned just days after the lay-off, says he and some co-engineers were on the hit-list until days before the announcement, when their names were mysteriously removed. He claims to know the name of the MEI manager who requested he be retained. MacGregor says MEI had no say over individual cases.

What's more, MEI and Solbourne are discussing an ambitious joint research project involving a low-cost workstation platform—a strange move for a company that has just abandoned that market. "On the same day that MacGregor's telling us there's going to be a cutback, I'm in the room with a Matsushita researcher who wants to give $3 million to the engineering staff for this project," says Ganousis. Minami confirms that there have been such discussions.

Despite these developments, the party line on the partnership remains rose-colored in both Longmont and Osaka. "Both of us want to see this company run well, and neither wants to pump more money into a losing venture," says MacGregor. "MEI has already tried putting a pileful of money on the table, and we didn't make good use of it, so now it's time I reestablished my credibility and make the most of our current assets." With the restructuring done, MacGregor expects the company to be profitable in 1992.

MEI has no current plans to extend Solbourne's line of credit or offer other financing until Solbourne proves it can stand on its own. "If it is well managed from here on out," says Minami, "we'll be at the table to talk about providing working capital if it comes to that." ☐

Beware of confused allegiances

EVERY COMPANY has departmental rifts, but the confusion that comes with a partnership can amplify such tensions to the point that employees are torn between two masters—especially if the employer is on the ropes and the partner is one of the most powerful companies in the world.

Many engineers at Solbourne Computer Inc. in Longmont, Colo., became disgruntled at the structured management style imposed by newly arrived president and COO Daniel Wilkie in mid-1990; they felt closer ties to Solbourne's parent and partner, Matsushita Electric Industries Co.

It's no wonder. Before Wilkie arrived, the company was an engineer's paradise. Founded by Douglas B. MacGregor, co-designer of Motorola's 68020 microprocessor, the company was singularly hell-bent on building a Unix workstation that would outperform the licenser of the underlying architecture they had chosen, Sun Microsystems Inc. in San Jose. "At one point, Solbourne had the finest group of engineers in the industry," says one former engineer who now works for Sun. "Sun still doesn't have everything Solbourne has."

Wilkie, a 17-year IBM veteran who had earned fame as the "father of the PC" for his manufacturing and distribution skills in the early 1980s, quickly brought in professional managers and his vision of corporate balance in an effort to grow revenues and take the company public in 1992. In December 1990, management cut a number of longtime R&D projects and laid off 25 engineers, hiring 20 sales and marketing people at the same time. "Engineering had been clearly dominating this company. We needed to build up distribution and minimize the cash drain," says Wilkie. He says these changes caused revenue to double to $24 million in the next six months.

Some engineers, aware of Wilkie's reputation, had already jumped ship. For those who remained, it became increasingly easy to take sides with the technology-driven MEI engineers with whom they shared their labs rather than the Solbourne managers who seemed intent on holding them back.

"We needed to build distribution and minimize cash drain," says Solbourne president Dan Wilkie

"The management structure made it impossible for me to function there," says one engineer who left last summer. "Wilkie's a good guy, but he doesn't understand anything about a high-tech engineering company. We were the types who kept sleeping bags under our desks; that IBM stuff just didn't work. Our allegiance was definitely to MEI." ☐

CEO REPORT

CASE HISTORY

Better together: Big Blue and little Easel

How a small software company forged a successful alliance with IBM in record-breaking time. Persistence was key

By E. B. Baatz

When R. Douglas Kahn, chief executive and president of Easel Corp. in Burlington, Mass., proposed to the company's board of directors in January 1988 that the privately held, 50-person, $3.3 million software company "establish communications" with IBM in the hope of successfully partnering with the 389,000-person, $54-billion multinational, the board concurred: He shouldn't waste his time. And who could blame them? IBM is inundated with requests for partnerships from all over the world every day.

Nevertheless, despite the board's advise, Kahn persevered. Sixteen months later, Easel had a deal that brought in IBM as a 10% equity stakeholder. For its part, Easel enjoyed a worldwide joint marketing and sales effort for its software—a graphical user interface for applications development—and had access to the software development plans of the world's biggest software seller.

IBM is a company that is strongly motivated to partner with other companies. "We view strategic alliances as absolutely critical to our success," says Catherine Lewis, Director of Application Development Marketing for IBM's programming systems line of business. A successful alliance with Big Blue is not guaranteed, however. Nearly 40% of large companies that have alliances with small companies characterize them as failures or as neutral ventures, according to a study of 94 large vertically integrated companies aligned with small venture companies done by Stockman & Associates of Greenwich, Conn., in early 1990.

Small fry succeeds with a giant

Manufacturing and product development alliance begun in 1989

Easel	
Industry	Software
1991 revenue	$28 million
Alliance goals	- Make product an industry standard - Expand distribution - Access to IBM s technical plans
IBM	
Industry	Computers and software
1991 revenue	$64 700 million
Alliance goals	- Access to graphical user interface software - Create customer user access standards

Results Both achieved initial objectives and have entered a second-stage alliance. Where Easel is now a formal strategic partner in IBM s AD/Cycle plan

Source ELECTRONIC BUSINESS

Kahn's odyssey required more than just perseverance in large doses. Along the way he formulated eight other rules that should be standard operating procedure for any small company seeking an alliance with a large organization. In addition to the obvious need to be an exceptional communicator, you have to find a champion in the big company, know your company's strengths, carefully craft a preliminary business agreement without lawyers, be flexible and willing to compromise, trust your partner enough to take risks, consider the day-to-day implementation by the field sales force, and manage expectations.

Of all Kahn's lessons, however, his persistence in piercing the IBM monolith was like the difference between getting to first base or getting stuck in the locker room. "Keep asking until you get a 'yes'—even after the *final* 'no,' " advises Allan Scherr, an IBM Fellow and vice president of its Technology Worldwide Consulting Practices who was involved with Easel in the early stages of the alliance.

In Kahn's case, this meant calling dozens of people he even remotely knew at IBM. When those efforts failed, Kahn approached Howard Hunger, IBM director of software vendor operations, at an IBM customer conference in the spring of 1988 to talk about the partnership possibilities.

Hunger was interested, but rather than inundate him with papers and conversation, Kahn decided to put together a special demonstration product to show Hunger the power of his application software. In a few months, a part-time Easel employee had written a prototype graphical interface to IBM's electronic mail system, and Kahn knew it would impress Hunger more than a flip chart or a slide show. Creative communication is much more likely to score a bull's eye when you're trying to get a big company's attention. "In fact, Hunger was so excited, he wanted to take our 'product' with him, which was not what we were selling," says Kahn.

THAT ONE DEMONSTRATION in June 1988 made Hunger a believer. He, in turn, became committed to helping Easel find the right partner within IBM's copious layers. Therein lay the third lesson: Find a champion within the big company. Hunger continually found IBM prospects to meet Kahn. Within a few months, IBM's Application Systems had agreed to be the sponsor, and Hunger, the matchmaker, moved on to other projects.

Once Kahn had IBM's attention, he needed rule number four: Deal from a position of strength. Kahn knew the heavy price of failure. The industry tabloids are full of stories of gnats trampled by elephants. Kahn felt strongly that he had a unique, user-friendly product that IBM could not find or replicate easily. He knew his product was his power. "When there were issues that we considered show-stoppers, we could look our partners in the eye and say, 'We cannot do the deal if that's the way its going to be structured,'" recalls Kahn. IBM officials were not able to take total control of the talks. "Power is not size," agrees IBM's Lewis. "Power is the added value that you bring to the table to meet customer needs."

Speaking of power plays, keep the lawyers out of the negotiations until *after* a preliminary agreement or memorandum of understanding has been prepared. The proposed business structure may create problems for the lawyers later on, notes Kahn, but the intent and philosophy in the original agreement will keep the attorneys focused. It changes the lawyers' orientation and makes them more responsive, he adds.

There are limitations to the use of a power position, so a willingness to compromise on issues that aren't a matter of corporate life or death is required. One potential complication between Easel and IBM came out of left field as far as Kahn was concerned. Easel was accustomed to selling a 99-year license to its customers, but IBM wanted a perpetual license. "IBM said, 'We expect to be around for 99 years and don't have any systems in place to collect all the software we've sold by then,'" says Kahn. "I said, 'Don't worry about it, I don't want the software back in 99 years.' They said, 'We have to worry about it.' That is a circumstance I'd never before encountered in my life: A very large company with concern for a very distant event." In the end, Easel simply went to a perpetual license.

"There was some exposure for us, but it was a calculated risk," says R. Douglas Kahn, Easel's CEO

Another legal technicality could have derailed the talks if Kahn had been inflexible. Due to trademark registration concerns, IBM was not willing to commit contractually to using the Easel product name throughout the world. "I looked the business people in the eye and said, 'Okay, I don't care about the exact words in the contract, but I want to be sure you understand exactly how important it is to call the product Easel,'" recalls Kahn. After some give-and-take, everyone agreed to use the Easel trademark, but IBM did not take legal responsibility for any infringements overseas. "There was some exposure for us, but it was a calculated risk we thought was worth taking," says Kahn.

Kahn's flexibility was in part inspired by his belief in the integrity and honesty of his future partner, and a strong sense of empathy—he was always trying to look at each of IBM's requests from IBM's point of view. He realized that, if you can trust your partner, then you can take calculated risks. His sense of trust was challenged by an IBM fetish.

IBM has this thing about source code. It wants to know every GOTO in the program. For Big Blue, selling someone else's software would be impossible unless it were comfortable with the quality of the source code. Easel, not surprisingly, wasn't too thrilled with the idea of letting IBM have its crown jewels. IBM's Scherr personally needed to get comfortable with the quality of the work already done and technical expertise of the Easel programmers. After extensive negotiations, Easel acceded to IBM's request.

Another contentious issue that IBM and Easel decided to confront head-on at the beginning of the negotiation was how to structure both sides' field sales groups and their compensation. "If you haven't established a good relationship at the field level, then you have a cancer that will erode the relationship," warns Kahn, "no matter how good it is at the senior executive level." Two different versions of the Easel software (an OS/2 standard edition and an extended edition) were sold separately to avoid unhealthy

"Position your products so they do not compete with IBM," IBM's Allan Scherr urges any potential Big Blue partner

"PERCEPTION IS ALL THERE IS."

Tom Peters, author of *In Search of Excellence*

Electronic Business

competition between the two sales forces. "Position your products so they do not compete with IBM," Scherr urges any potential Big Blue partner.

Today, Easel-trained IBM sales specialists are encouraged to develop close relationships with the Easel sales team, says Leon Stuckenschmidt, manager of market development for IBM U.S. marketing. Easel, in turn, hired a sales manager and a marketing manager to oversee the day-to-day relationship with IBM.

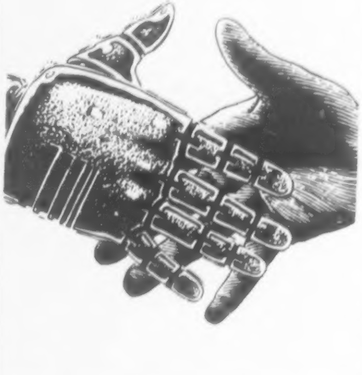
Kahn and Easel's negotiating stance was strengthened by the fact that he deliberately kept his enthusiasm and high expectations from fueling the employees' and the board's expectations. "We put our business plan together for 1989 with the assumption that there would be no IBM deal, even though, at that point, we were well into the legal negotiations," explains Kahn. "Up to the last minute, I wanted to be able to step back from it all and ask, 'Does this make sense for our business?' " The lesson: Manage expectations.

FOUR YEARS AND many millions of dollars in revenue later, Kahn's company is now a strategic partner with IBM in the every sense of the word. As a one of IBM's seven AD/Cycle Business Partners under IBM's Programming Systems Division, Easel's graphical user interface software is a key tool in IBM's application development plans. The companies collaborate not only in marketing Easel's software, but also in research and development. Revenue from IBM accounted for around 20% of Easel's total sales in 1991, down from 46% in 1989. To keep the deal on track, there are daily applications of the lessons learned. Communication is maintained with monthly update reports by both companies' alliance managers, regular upper management meetings, Easel/IBM pizza lunches at IBM field sales offices, Easel's relatively free and open access to the myriad of management layers within IBM, and frequent communication with customers about the alliance. Mutual self-interest helps, too. □

Mercedes-Benz and Bose thought they knew everything. Surprise!

It took six years for them to develop the "ultimate" sound system for the "ultimate" luxury car

By Barbara Jorgensen



A joint venture between specialists in disparate industries—in this case consumer electronics and automobiles—can be a lot more complicated than your typical high-tech alliance. Beyond the need for each other's expertise, they have little in common—their training, technology, and marketing philosophies are usually quite different. What cross-industry partners frequently do have in common, however, is a lack of knowledge about the other's industry. For the partnership to succeed, they must achieve a mutual comfort level by overcoming this "stranger anxiety."

The alliance between loudspeaker pioneer Bose Corp. in Framingham, Mass., and prestigious automaker Mercedes-Benz AG (MB) in Stuttgart, Germany, enabled both companies to conquer their fears when together they developed the ultimate sound system for MB's top-of-the-line S-class sedan. Among some of the hurdles the two organizations faced was a language barrier—not as much in the translation of English to German, but in the translation of audio's subwoofer jargon into the aerodynamic-speak of automaking.

Surprisingly, the two companies' well-known devotion to quality through engineering didn't quell the stranger anxiety between Bose and MB. In fact, the partners found their uncompromising attitude toward technical excellence an occasional obstacle: Optimal performance for one often diminished the performance of the other. Compromise required more than patience; it needed a scientific foundation to the discussion befitting two technology-oriented companies.

Cost implications were only a secondary consideration because of Mercedes's emphasis on the quality of its $70,000 to $120,000 cars and the feedback from customers about disappointing performance of earlier sound systems.

"Mercedes-Benz was very concerned about quality," recalls Sherwin Greenblatt, president and COO of Bose. "It has an image of quality, but its reality was also good—everything was based on engineering." A superior sound system was also crucial for MB because its customers had high expectations.

Typical of a quantification-oriented approach of an engineer, stranger anxiety was first eased by generating data to show the high caliber of the partner. Mercedes conducted a contest among potential sound-system suppliers, and Bose's designs convinced MB officials that Bose was the best. The lengthy exercise also helped Bose determine that the partnership would be worth the effort because of the technical challenge involved. "Mercedes-Benz was very demanding," recalls Greenblatt, "but we play for the long run. We were persistent, patient, and entered the contest—we had never competed at that kind of level before." That's quite a statement—in the mid-1980s, Bose had developed its first custom sound system for General Motors Corp.'s Cadillac line.

What happens when the elite meet

Design, engineering, and marketing alliance begun in 1985

Bose

Industry	Consumer electronics
1991 revenue	$400 million*
Alliance goals	· Expand OEM customer base · Maintain high standards with custom designs

Mercedes-Benz

Industry	Automobiles
1991 revenue	$20,700 million*
Alliance goals	· Offer superior custom sound system · Optimize sound for rear passengers

Results Objectives achieved after six years of development when new sound system was introduced as part of Mercedes top-of-the-line S-class sedan in October 1991. Initial market acceptance is positive

*Estimate Source: ELECTRONIC BUSINESS

In fact, about 25% of its $400 million a year in revenue comes from contracts with OEMs such as Mercedes, Cadillac, and Zenith.

"Mercedes-Benz was very demanding, but we were persistent and patient," recalls Sherwin Greenblatt, Bose's president and COO

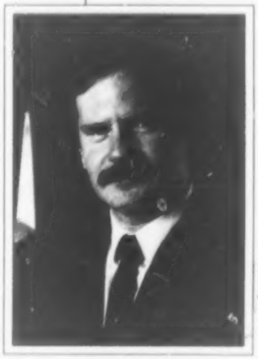
After establishing a mutual respect between the partners, a successful cross-industry alliance requires each partner to be willing to teach, and to learn from, the other. Bose and Mercedes soon realized that they had to relearn product design and placement. Most of Bose expertise focused on optimizing audio performance for the driver, while Mercedes-Benz wanted an acoustic system offering optimum performance to back-seat passengers as well. The reason? U.S. car owners operate their own car, but European luxury cars are likely to be driven by a chauffeur.

MB's insistence on back-seat sound quality forced Bose to rethink its designs, and in the process it had to teach the automakers a few things about acoustics and interior design. Mercedes's tradition of positioning speakers in the rear package shelf meant sound, particularly high frequencies, were localized—listeners could pinpoint its origin rather than being "bathed" in it. Bose insisted on two sets of speakers for the back of the car to prevent localization. As a result, each rear door contains a 3.5-inch speaker and, in addition, four 6.5-inch low-frequency bass transducers are mounted in the rear package shelf.

"MB engineers had to be more flexible than they had been used to," recalls John L. Wilson, OEM division marketing and sales director for Bose. "They are not accustomed to having a supplier tell them the finer points of where things belong inside a car." Adds a sympathetic Roland Utenwoldt, Mercedes-Benz North America product planning manager, "As the car design came together, Bose lost the right to certain mounting locations and couldn't reach its accustomed performance levels."

The quantification-oriented approach continued to provide a methodology for solving problems. For example, Bose's original design included large speakers within front car doors, explains Bose's Wilson, to provide balanced and realistic audio reproduction in an auto interior where glass and upholstery reflect, distort, or muffle sound. MB considered the large speakers unacceptable in a luxury line starting at $70 000 because they interfered with the car's access and egress systems and interior design. Bose demonstrated to Mercedes that smaller speakers would produce an inferior sound. "If you can give someone a scientific explanation for something, they are more willing to accept it," notes Wilson.

After reviewing the data, MB was willing to consider Bose's novel solution to the problem. To project sound toward listeners and augment the output of the smaller door-mounted speakers, Bose designed a two-inch loudspeaker invisibly embedded in the rear-view mirror behind the windshield. "Bose used a technical solution to maintain its desired level of quality and reduced the space they occupied in the car," says Utenwoldt.


Jeffrey Vock

"As the car came together more and more, Bose lost the right to certain mounting locations," recalls Roland Utenwoldt, Mercedes-Benz North America product planning manager

Mercedes and Bose developed an innovative approach to another component of stranger anxiety that bedevils cross-industry alliances. The huge and staid German car maker was skittish about allying with a specialized, private U.S. speaker company thousands of miles away. MB was concerned about Bose's ability to meet volume manufacturing demands and to provide the components on a just-in-time basis.

The partners found a simple but elegant resolution—they worked through a familiar third party. A German plastics company, Reitter-Schefenacker KG (R&S), was supplying Mercedes with its taillight assemblies and was known by Bose to be a top-notch supplier of plastic enclosures. Bose and Schefenacker formed a sub-alliance—Bose manufactures its speaker assemblies, electronic modules, and components in the U.S. and sells the subassembly to R&S. The German company, in turn, molds the speaker enclosures, assembles the system, and sells the system to nearby Mercedes.

Six years of such flexibility and compromises, standard operating procedure for any relationship, culminated with the October 1991 introduction of the new S-Class sedan with the Beta sound system from Bose as standard equipment. Although neither side is willing to say whether their collaborative relationship will be a financial success after the "millions of dollars" in development costs absorbed by Bose because "it's too soon to tell," the company's officials are optimistic. Both Mercedes-Benz and Bose cite cases in which the sound system contributed to a sale. "Both the automotive and audio press response has been favorable," adds Mercedes-Benz's Utenwoldt. The consumer press has been equally enthusiastic. "Startlingly real sound reproduction for all passengers in the car," exclaimed *Popular Science* magazine when it named the Bose system one of the 100 greatest achievements in science and technology last year. ☐

CEO REPORT:

CASE HISTORY

A buyer-supplier alliance that really works

Conner Peripherals and Compaq Computer show how start-ups can cut their risks while supplying big customers with cutting-edge design

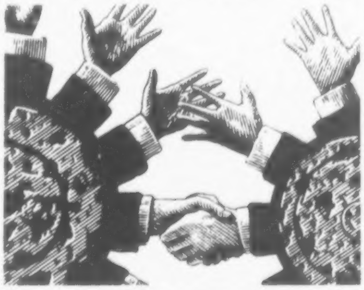
By David Webb

What do you get when you mix a hard-driving Silicon Valley marketer, a cool-headed Texas engineer, and $12 million in cash? In the case of Conner Peripherals and Compaq Computer, you get an example of how customers and suppliers can team up to blitz their way to the top of the list of the fastest-growing U.S. companies.

The lessons in the Conner-Compaq alliance are not limited to those companies. For small, innovative companies, the key is to find a customer with a specific need, prove you can fill that need, then leverage the relationship into a fast-growing market for your product. Larger manufacturers, meanwhile, should ferret out suppliers that offer cutting-edge technologies *and* smart investment opportunities. While Compaq's up-front investment in Conner was designed mostly to provide the Houston PC maker with a supply of custom-tailored high-performance disk drives, the financial payoff to Compaq is hardly small potatoes: The company now holds about 21% of Conner's stock worth $239 million.

The relationship began in 1986 on a handshake between Finis Conner—now CEO of San Jose-based Conner Peripherals—and Rod Canion, then Compaq's CEO and president. Conner had been courting venture capitalists in hopes of launching a company that would produce a disk drive designed specifically for Compaq's computers. "I talked to Rod as a customer, and he offered to make the initial investment," recalls Conner. "It was a perfect match."

The deal allowed Conner to reject the venture capitalists' offers in lieu of a $12 million cash infusion, paid in two equal installments. (Conner raised an additional $27.5 million from venture capitalists in 1987; the company's 1988 initial public offering raised $275 million.)



How Compaq created its own supplier

A buyer-supplier alliance begun in 1986

Compaq Computer

Industry	Personal computers
1991 revenue	$3.3 billion
Alliance goals	- Receive steady supply of customized, high-performance disk drives - Return on investment

Conner Peripherals

Industry	Disk drives
1991 revenue	$1.6 billion
Alliance goals	- Reduce start-up risks - Secure high-volume customer - Access disk drive technology

Results: Alliance considered successful, with no important changes in five years. Both have been fast-growth companies, partly because of advantages from alliance

Source: ELECTRONIC BUSINESS

The alliance has dished out some handsome rewards to both companies. On its side of the table, Compaq can count on a steady supply of drives at can't-be-beat prices, essentially built to its own demanding specs. On the other side, Conner was able to launch his company with virtually none of the risks associated with undercapitalization, an unproven technology, or a lack of big-volume customers. "If you have a customer and the cash, and if you clearly understand what the market needs, you dramatically reduce the risk," says Conner. "Our risk was less than any other Silicon Valley start-up I can think of. Otherwise, I don't believe we would have been able to ramp up production to $113 million in our first year."

Conner Peripherals' revenue last year came in at nearly $1.6 billion. Compaq Computer, meanwhile, rode its innovative PC technology (bolstered to some degree by Conner's drives) to sales of $3.3 billion in 1991. Interestingly, Compaq became the fastest-growing U.S. company of all time in 1989. Conner Peripherals took the title away from Compaq.

The success of the Conner-Compaq alliance involved a little luck and fortuitous timing, of course. To begin with, Conner had neither a plant nor a working prototype of the drive—only a design pegged to Compaq's 386-based systems, which called for

REPRINTS

Whenever your company activities or products are reported in the pages of a Cahners magazine . . . whether in a feature article . . . in a news story . . . or an article on new products or technological innovations . . . we can custom-design a Reprint for you to use in your sales, marketing, and public relations programs.

You can also include your advertising message in the Reprint so that it becomes your own special company promotion piece. Reprints can be a single sheet or a multi-page brochure. And the cost is surprisingly low, whether your order is in the hundreds or the thousands.

Consider these many uses:

- Mailing to your promotion list or customer list
- Distribution at trade shows or conventions
- As a leave-behind or sales tool for your sales staff
- As a public relations or public service release
- New product announcements

Electronic Business

For details contact:
CAHNERS REPRINT SERVICES
P.O. Box 5080
Des Plaines, IL 60017-5080
(800) 323-4958

higher drive capacity and performance than what was previously available. Compaq had been buying drives from Control Data Corp.'s drive division, now owned by Seagate Technology Inc., but was not entirely satisfied with the technology.

Thanks to the Compaq alliance, "Our risk was less than any other Silicon Valley start-up I can think of," recalls Finis Conner

Conner also benefited from Compaq's strategy to downsize its portable systems into the realm of laptops and, eventually, notebooks. Although Seagate had written off the market for smaller form factor drives, Conner decided to jump in as a supplier of high-performance 3.5-inch drives, providing a perfect fit with Compaq's marketing plans and critical production schedule.

Striking the alliance required a certain measure of trust on Compaq's part. The computer maker set out to reduce the inherent risks by making sure that Conner understood what was required in the drives. "You can design a product you *think* your customers want, or you can design one that your customers have *told* you they want," says Wayne Collins, Compaq's vice president of worldwide business planning. "We defined what we needed so Conner wasn't left guessing."

"We defined what we needed so that Conner wasn't guessing what the market wanted," says Compaq's Wayne Collins

Such sharing of proprietary information can be risky, of course. The key was trust. "Once the relationship was established, both companies felt comfortable enough to open their kimonos," says Collins.

Under the six-year contract, Conner agreed to sell its drives to Compaq at prices below those offered to any other customer. Otherwise, says Collins, Compaq's investment had no bearing on the companies' relationship. "As far as day-to-day operations are concerned, [purchasing] is free to treat Conner as they would any other supplier."

Nor was Conner bound to Compaq under the alliance; it was free to market to Compaq competitors. As far as Compaq was concerned, in fact, it was to the PC maker's advantage to allow Conner to grow competitively as a merchant market supplier, notes Collins. The result was that Conner was not only able to leverage Compaq as its primary investor and its initial high-volume customer, but Conner also used Compaq as an oracle of demand for open-market personal computer disk drive specifications. The relationship, in other words, gave Conner a first-hand look at what customers demanded from PC vendors—especially the features of disk drives.

That's not to say everything was always rosy between the two companies. In some cases, Conner was Compaq's only source for disk drives, but Conner was also supplying other customers. It wasn't always easy to reconcile production schedules to everyone's satisfaction.

On the whole, though, both companies claim that the relationship has suffered only minor gaffes. Indeed, the terms of the alliance have not been significantly amended in its five-year existence. "The partnership process isn't always blue sky," says Collins. "Sometimes you come to a problem and you have to set a new course. In doing so, you build the relationship." ☐

Words from on high

Execs are far from unanimous on what government can do, whether megadeals are worth it, and what's ahead for alliances

By E. B. Baatz

1. What is the most important thing government can do to make building alliances easier and more effective for your company?

John McHale
President and CEO
NetWorth Inc.

First, government should provide more tax incentives for R&D. Second, it should develop a clearinghouse for companies looking for strategic partners—a one-stop shop for companies to find out who is involved in particular industry niches and who to contact.

Since Infonet establishes strategic alliances in different countries to provide global business communications services, the communications ministry in each country must ensure fair business practices without favoritism. In addition, governments in developing countries should commit to improve their telecom infrastructures. Without such commitments, Infonet cannot expect new partners in Eastern Europe, for example, to uphold the standards our customers demand.

Jose A. Collazo
Chairman and president
Infonet Services Corp.

Government can play a supportive role, rather than a directive role, in these situations. The Commerce Department, for example, could make alliances move faster by helping to set up meetings in which companies present their wares to potential distributors and partners. I would like the government to move things along—expedite the process, rather than have a policy for or against strategic alliances.

Gabriel P. Fusco
Chairman and CEO
Sequoia Systems Inc.

Orlando Gallegos
President and CEO
Crosspoint Solutions Inc.

The most important thing that the government can do is to help protect intellectual property in every major market of the world. Government must also work to reduce the cost to file and process patents in foreign countries. Our company has estimated that our current costs to file patents in Japan and Europe will be over a half million dollars. Add to that the cost to file patents in the Asia-Pacific countries, which are major emerging markets, and you can see that a cost of more than $700,000 can become a major deterrent to a start-up that is looking to protect its intellectual property.

Peter Behrendt
Chairman, president, and CEO Exabyte Corp.

I see government's role to be relatively limited, with one exception: keeping a strong, stable dollar. One of the keys to successful partnerships is predictability. I find that even in successful relationships, when the dollar weakens—and, therefore, the cost of doing business with an overseas partner increases—the relationship can be strained.

James G. Favier Jr.
President
OCG Microelectronic Materials Inc.

In this period of increased collaboration among companies, government could more clearly define antitrust policy as it relates to alliances. Antitrust concerns seem to be a major roadblock in building alliances and making them effective in the shortest period of time.

2. Which specific strategic alliance do you think has been extremely successful, and why?

Harold A. McInnes
Chairman and CEO
AMP Inc.

The Corning Company has several [alliances] going back many years with Dow, Siemens, and Owens. Why have they worked so well? Each of the ventures brings together capabilities that complement each other and the management styles or cultures seem to be in step. Also, the Corning ventures have been successful because they were formed as stand-alone corporations and report to separate boards of directors.

Robert P. Akins
President and CEO
Cymer Laser Technologies

The Texas Instruments/Hitachi alliance is a good example of a successful and sustainable alliance between two international companies. The extension of their original 16-megabit DRAM program to include 64-Mbit DRAM development opens both companies to additional development talent, manufacturing process improvements, and market access. The alliance strategy is focused, brings the benefits of cost and risk-sharing, and gives each company a win.

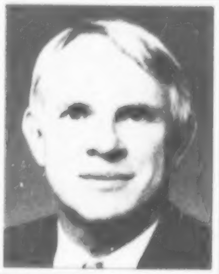
William J. Warwick
President
AT&T Microelectronics

The agreement between Motorola and Toshiba appears to be a very balanced deal in which the expectations and needs of both parties were thought out before the agreement was struck. Motorola gained access to a manufacturing process that was later applied to its own products; Toshiba gained access to a technology that broadened its knowledge base. This is critical to be successful.

3. Will the recent or planned "megadeals" improve the U.S. electronics industry's overall global competitiveness?

Gary Kennedy
President
Orbit Semiconductors Inc.

I am not aware of any good "megadeal" to date. The main alliances consist of U.S. companies giving rights to products or technology in exchange for cash or an equity investment into the U.S. company. They have been fostered because of the lack of investment funds in the U.S. The U.S. investment community is too myopic, seeking strictly short-term results each quarter. To combat this, we should adopt a policy that compensates long-term investors.



Carl McCormick
President and CEO
Group Technologies Corp.

Megadeals, in and of themselves, will not make the U.S. more or less competitive. It is the astute management of one's resources coupled with vision and an appetite for risk that ultimately determines one's competitiveness. What the megadeal provides is a new arrangement of resources to be managed, which opens up new possibilities. These new possibilities do have the potential to greatly contribute to increased competitiveness.

I'm skeptical. Innovation is derived more from lots of small companies with the right kind of entrepreneurial spirit and freedom from all the bureaucracy and baggage that comes with large corporations, as long as they have access to capital. The deals that will move the U.S. electronics industry ahead are the ones between a large corporation with the wherewithal and a small corporation with the incentive and the motivatien and the specific talent and the focus.

Kent B. Godfrey
VP marketing
Epoch Systems Inc.

4. What do you think will be the most important changes in strategic alliances during the next decade?

These alliances will actually become "real," with many of the larger ones closely emulating Japan's vertically integrated companies. What I mean by that is that it's commonplace today to announce strategic alliances left, right, and center. Very few of these announcements result in real actions that make a difference. The fad will pass. Over the next decade, strategic relationships with real teeth and real power will begin to happen.

Thomas H. Bruggere
Chairman and CEO
Mentor Graphics Corp.

Larry McArthur
President and CEO
Aries Technology Inc.

If strategic alliances can be made to work, then they can offer an alternative to mergers. I expect that there will be more strategic alliances and fewer mergers in the '90s. Why? Because alliances don't destroy the successful management team of the company you're looking to align with; mergers, on the other hand, do. Alliances provide a barrier to how much you can screw up.

The need for instant market presence, leaps in technology, and decreasing product life cycles mean that the next decade will become the decade of the value-added business. That means that businesses will have to focus on what they do best while they develop their products faster. If we can rely on other "expert businesses" to provide their own added value, the businesses of the next decade will be able to flourish. From the enhanced vendor partnerships of the '90s to the joint ventures and the alliances of all sorts, these relationships work to maximize the leverage gained by investment in technology.

Michael Shealy
President and CEO
Digital Technology Inc.

ALLIANCES' FUTURE

The "Virtual Enterprise": Your new model for success

Vertical integration is out. Today's markets require a broad fabric of alliances for managing the entire value chain

By L. Scott Flaig

The trend toward strategic partnerships and alliances among electronics and other manufacturing companies is far more than an industry fad or new management experiment. Today, these alliances are actually reshaping the basic nature and structure of the business enterprise and are challenging our old models for success.

The emerging model for successful business is the "virtual enterprise." Its basic goal is to deliver to the customer, in as timely a fashion as possible, the lowest-cost, highest-value product that the entire value chain—not just a single company—can produce. Partners in a virtual enterprise don't focus solely on controlling internal costs and processes. Instead, within the context of cooperative effort, the virtual enterprise manages the total value chain leading to the end-customer through a fabric of alliances with suppliers, manufacturers, distributors, and others.

The results are often better product design, better product quality, improved time-to-market, and almost always superior bottom-line results than for vertically integrated enterprises.

To some extent, this isn't new thinking. Many electronic executives, though unfamiliar with the new terminology, have been reshaping their organizations in light of the advantages of the virtual enterprise. They're increasingly focused on adding value to the specific processes in which their companies excel, while at the same time seeking to off-load and manage the rest of the value chain through cooperative relationships and alliances.

Historically, vertical integration was always seen as the surest way to succeed for a manufacturing company. By bringing inside the organization as much of the value chain as possible, the reasoning went, a manufacturing company could best manage and control its costs and thus achieve competitive advantage. The old thinking held that vertical integration was the only way to completely master your destiny and minimize your vulnerability.

Webb Chappell

The virtual enterprise lets companies focus on what they do best and off-load other functions, says L. Scott Flaig

TODAY, BUSINESS IS drastically different. The complex requirements for success—specialized knowledge, high-value components, improved time-to-market, customer responsiveness, and organizational excellence—have made it much more difficult and even undesirable to directly control all business and manufacturing processes. Nowhere is this more true than in high technology and electronics where capital costs are so high and technology advances so rapid that it's difficult to stay current in one discipline, let alone many.

One result is that the electronics industry has been faster than many to adopt the virtual-enterprise strategy. In essence, this model seeks to master complexity by disaggregating selected functions and building relationships throughout the value chain.

For example, Unisys, one of the three largest computer makers in the U.S., has just announced it will abandon internal manufacturing of integrated circuits for internal consumption. It was unable to add sufficient value in this activity or derive sufficient competitive advantage for the resources expended. Predictably, this shift to increased dependence on external suppliers requires more cautious management of the supply chain. IBM, for example, has reportedly invested capital in no fewer than 200 important suppliers and partners to protect and enhance the ability of these companies to add value to IBM's customers.

Reliance on partnerships also forces the virtual enterprise to focus its attention outwardly—on its partners—as well as inwardly. Value-adding processes that were once hierarchal elements within an organization now become peer-to-peer relationships between allied companies. Ownership of internal processes must give way to collaboration and communication. Direct management and control give way to shared responsibilities and goals.

LIKE RUNNERS ON a finely tuned relay team, each member of the virtual enterprise has his or her own talents, but no single runner has the wherewithal to beat their competitors to the finish line. To carry the analogy further, the team must not only compete together, but also must train together to ensure achieving a maximum performance in competition.

This mingling of expertise enables the virtual enterprise to be much more flexible than vertical corporate counterparts when responding to competitive pressures and emerging opportunities. The virtual enterprise can more easily change from one technology to another more promising technology, it can more quickly shift from one product to another product, and it can better penetrate new geographic markets.

Consider, for example, the virtual enterprise's strength in developing a worldwide strategy. If the skills to supply, manufacture, and distribute your product are already available in target market regions, there's no need to duplicate the local infrastructure. You can also expand globally without making massive investments in capital equipment. Finally, it's a key strategy for attacking protected markets, where partnering with local suppliers and use of local labor may be required either formally or informally. This is especially true in Japan and Europe.

The switch to strategic outsourcing also helps virtual enterprises avoid making investments in antiquated equipment and technology. At the far end of the continuum are fabless semiconductor companies, such as Cirrus Logic, which realize tremendous advantages by relying on partners with state-of-the art process technologies. Contrast that with a philosophy that emphasizes building rather than buying some components. Pursuit of the latter can too often lock an enterprise into outdated technology and render it unable, for capital investment and depreciation reasons, to take advantage of advances in new materials, processes, or product designs.

If the skills to manufacture and distribute your product are already present in target regions, don't duplicate them

Again, the point is that virtual enterprises permit constituent partners to focus exclusively on what they do best. In these circumstances, any business support process or nonstrategic added-value process also becomes a candidate for outsourcing to a partner. This can extend to traditional internal overhead functions—inventory management or accounting, for example—and other indirect costs. The overall and desired result, of course, is improved services to the customer and reduced costs to the service supplier.

Ultimately, a powerful network of independent, yet virtually integrated, companies could have levels of business and interlocking equity holdings among all its members. Networked members can coordinate closely in developing future products

What's different and how you'll benefit from the virtual model

Vertical enterprise	Virtual enterprise	Benefits/Changes
Inward focus on all aspects of product development and manufacturing	Outward focus on partner expertise and resources	Result should be faster feedback from customers and better use of scarce resources
Hierarchical management structure within company	Peer-to-peer collaborative management within the alliance	Many managers must be retrained to handle more complex product development and lack of absolute control
Communication links are primarily closed and within the organization	Communication links must be open and spread throughout the enterprise	Adoption of online communication system is a must. Use of open system strategy is required
Technology is closely guarded to maintain control and competitive edge	Technology sharing among partners is required	Trust between partners is required. Payoff is faster, more enhanced product development
Capital spending burden may be large to encompass all processes internally	Capital spending is spread among alliance members	Upgrading is less costly and more likely to happen quickly because individual alliance members focus on what they do best

Source: Ernst & Young and ELECTRONIC BUSINESS and share senior technicians and intellectual assets. Enterprises consisting of world-class companies are likely to find that their influence offers preferred status with respect to capital formation.

UNDERSTANDING THE benefits of the virtual enterprise is one thing; creating a successful business based on the model is another. Many obstacles have hampered efforts to adopt the cooperative model. For example, vertically integrated organizations usually feared transferring technology to suppliers. The technology, they felt, represented their competitive edge. Likewise, suppliers were less likely to share advances in process technology and other developments with a vertically integrated company. This has changed slowly as companies recognized they could not do all things equally well. Successful strategic partners understand that sharing expertise is critical for making collaborative efforts work.

Adopting the virtual disaggregated model also requires a major strategic reassessment of the manufacturing and business processes required to design and build your products. The decision to create a virtual enterprise should include a compelling new business strategy that permits the enterprise to take full advantage of its new strengths. For example, the need to penetrate global markets or to achieve faster time-to-market may require a new cooperative approach to a company's business, development, and production processes.

Frequently, the model will emphasize retention of critical proprietary manufacturing processes and of potentially high-risk components and processes. Major computer manufacturers such as DEC, IBM, and Hewlett-Packard—unlike Unisys—have taken this approach with certain semiconductor devices. These companies believe innovations in their product are driven by advances in these proprietary components and they, therefore, strive to control critical links in the value chain.

Other important functions that are deemed critical to influencing and managing the value-added, such as planning, CAD/CAM, and purchasing, can also be retained within the company. Other less strategic business processes, such as data processing, transportation, and warehousing, are considered for outsourcing. Clearly, product management is more complex in this model, but it can also be more responsive to product changes, technology advances, and geographic dynamics. Managing this kind of product development process requires the close relationships found in strategic alliances.

New managerial skills, such as peer-to-peer decision making between allied companies, must be developed

Communication between the members of a virtual enterprise is another vital link to achieving success. Consider that a major management goal within the virtual enterprise is the creation of a new disaggregated organization that resembles a vertically integrated company that has "co-located" processes and facilities. That can be achieved only through sophisticated on-line communications and a commitment to using them. It is also important to pursue an "open systems" approach to communication because the virtual enterprise is apt to include many independent and geographically dispersed companies.

The dynamics of the virtual enterprise are still evolving, and management's lack of familiarity with them is a major challenge. For example, managing culture becomes more difficult and problematic as the organization evolves from a single location, to multiple locations, to a virtual enterprise of independent business units. Choosing the appropriate partners is critical. Companies that take part in the virtual enterprise must be committed to the partnership and to the goal of meeting the ultimate customer's needs. A compatible corporate culture, backed up by a "win-win" mind-set on the part of management, is essential to formation of an effective alliance.

Because the demands of managing the virtual enterprise are somewhat new, and because those skills are not typically learned either in school or on the job, many managers must "go back to school" to become effective alliance builders and partners. They frequently lack the skills to manage cooperative, peer-to-peer activities in the context of multiple facilities, functions, international cultures, and independent alliances.

In selecting alliance members for a powerful world-class value chain, the architects of the virtual enterprise must find advocates of contemporary methodologies, technologies, and processes. For example, the effective alliance member will have a real understanding of and commitment to just-in-time and total quality principles, to electronic data interchange, quality function deployment, and quality information systems. DEC and Xerox, for example, have been leaders in formalizing these kinds of principles in their relationships with suppliers, customers, and other strategic partners.

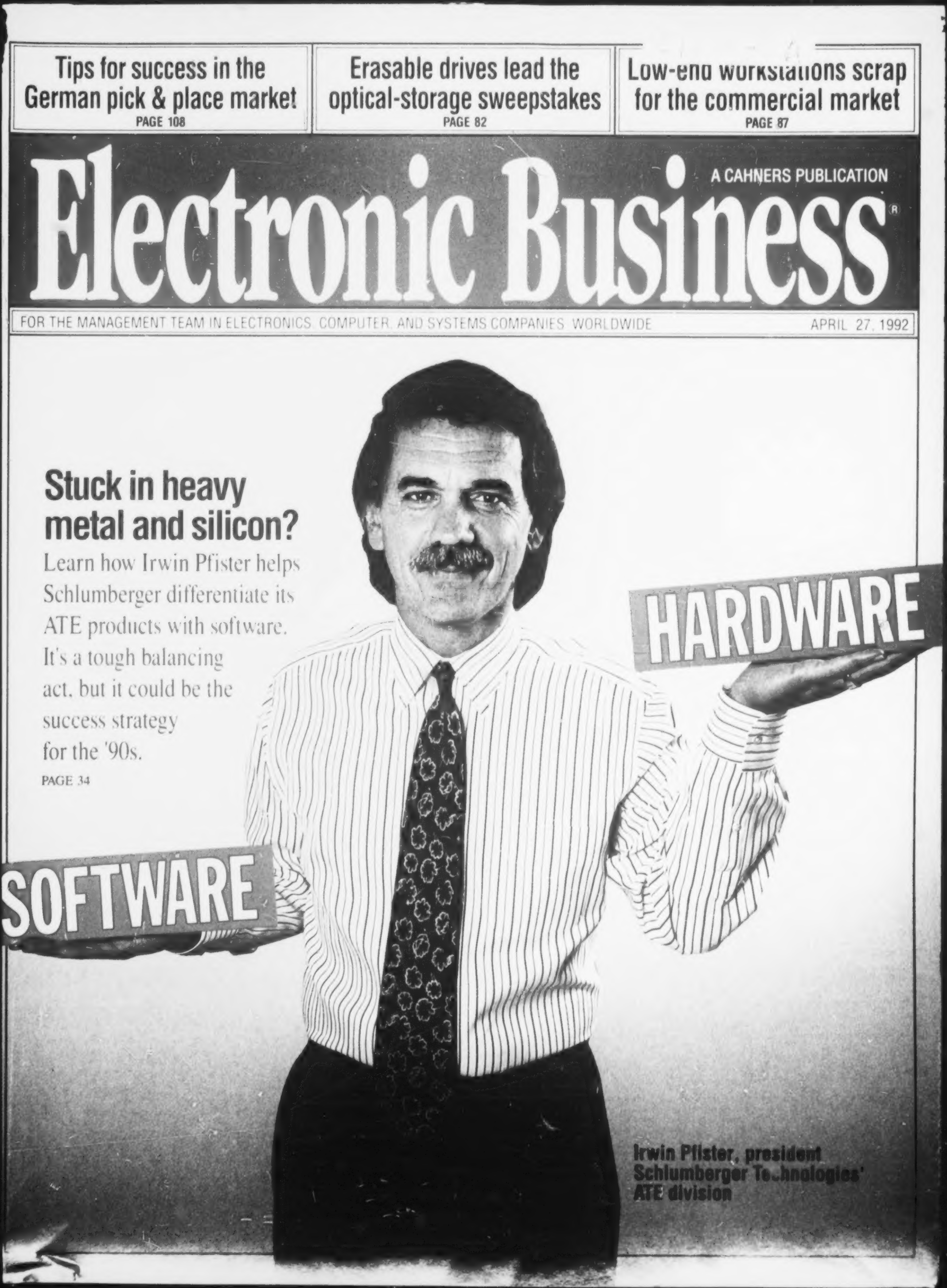
In the final analysis, any company that views cost, quality, time, and globalization as critical issues will need to look to the virtual model for guidance in the 1990s. Nevertheless, there are significant risks that need to be recognized, and it's important that companies understand the nuances of culture and the technology to make the new model work. ☐

L. Scott Flaig is co-national director of Ernst & Young's Manufacturing/High-technology Industry Services and manages the programs associated with the sector's integration, audit, tax, and consulting services. Flaig has spent 25 years in the manufacturing sector and has held executive positions in manufacturing, logistics, purchasing, and engineering with three Fortune *100 companies. His first book,* Integrative Manufacturing: Transforming The Organization Through People, Process, and Technology, *will be published in late 1992.*

NOTE

ONLY THE FOLLOWING PAGES OF THIS
PUBLICATION HAVE BEEN FILMED

Cov. 1, Pgs: 4, 5, 9, 13,
14, 16, 27, 28, 61, 62, 64,
66, 87, 88, 90, 96-100,
108, 109



Tips for success in the German pick & place market
PAGE 108

Erasable drives lead the optical-storage sweepstakes
PAGE 82

Low-end workstations scrap for the commercial market
PAGE 87

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

APRIL 27, 1992

Stuck in heavy metal and silicon?

Learn how Irwin Pfister helps Schlumberger differentiate its ATE products with software. It's a tough balancing act, but it could be the success strategy for the '90s.

PAGE 34

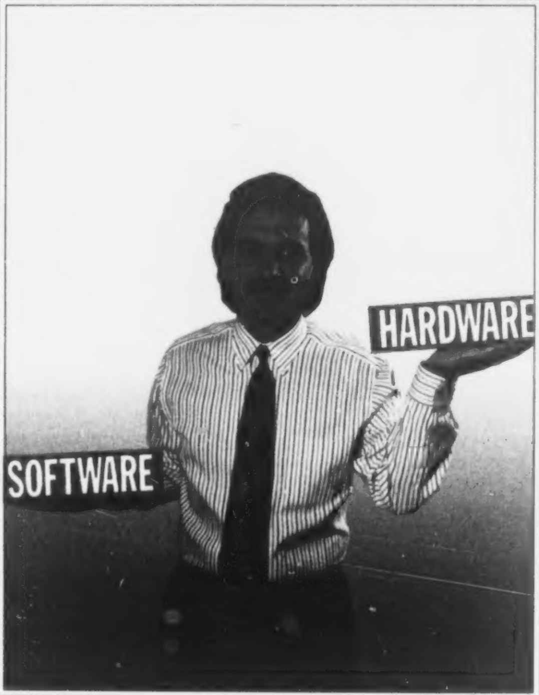
Irwin Pfister, president Schlumberger Technologies' ATE division

Electronic Business

VOLUME 18, NUMBER 7

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

APRIL 27, 1992



PAGE 34 Irwin Pfister, president of Schlumberger's chip tester division

COVER STORY

PRODUCT DEVELOPMENT & MANUFACTURING

34 How to make software pay in a hardware world

Schlumberger Technologies' IC test equipment division—in many ways, the ultimate hardware business—has invested heavily in proprietary software as the best way to set its products apart from the competition. While the company's software has climbed from 2% of total sales to about 20%, some wonder how many customers will pay for the products they once got for free

Cover photo by Liane Enkelis

UPFRONT

Business Trends

13 End of the stock-options party?; Slow Japanese market hits U.S. imports; Customer perception may stall pen-based market; Big companies squeeze IS budgets again; Tough stance on visas could mean more U.S. jobs; Low-cost quality seminars from Baldrige winners

PAGE 13 Will targeting executive stock options hurt high tech start-ups?

Companies to Watch

23 Saving time with logic emulators from Pie Design Systems; Teknekron Communications Systems helps manage networks; Software from TeamOne Systems coordinates concurrent engineering

Business Barometer

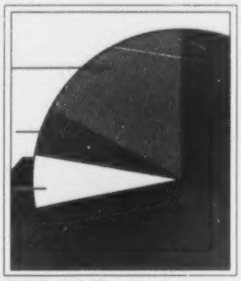
27 Forecasts
Lower interest rates will revive revenue growth

28 Leading Indicator
Leading Indicator up, up, and away?

PAGE 61 Finding the right partner in the systems integration dance

File Edit Tools

PAGE 96 Creating multimedia presentations is easy with the use of Macintosh software



PAGE 108 The German market for pick-and-place equipment

FEATURES

PRODUCT DEVELOPMENT & MANUFACTURING

33 **Why all the fuss over software?**
Hardware is declining as the main source of industry profits. Smart companies know that software is the real differentiator

47 **National Instruments profits by balancing hardware with software**
The company has managed to grow 40% per year by tying its application development software to a quiet but steady stream of equipment sales

53 **You're in the (software) army now**
Whether you make aircraft or microwave ovens, your real business is software. Companies that don't understand that are doomed

BUSINESS STRATEGY

61 **Finding the right partner in the systems integration hustle**
It's a $20 billion business, and it's growing 20% a year, but integrators' desire to be hardware-independent make them fickle allies for OEMs

FINANCE & ECONOMICS

75 **Why no one's noticing the nascent recovery**
As long as jobs and profits are in the dumps, other signs of an upturn offer little solace

MARKETS

82 **Optical storage finally arrives**
The optical-drive market could grow to $3.6 billion by 1994

87 **A clash of giants shakes the low-end workstation market**
Sun, DEC, IBM, and HP battle for market share as they push low-end workstations into commercial areas

96 **Multimedia mania: Time for a reality check?**
The marriage of PC, VCR, and TV may soon spawn a multibillion-dollar market

INTERNATIONAL

108 **Germany's spending cuts batter pick-and-place vendors-**
U.S. suppliers must offer top-notch service to grab the few remaining opportunities

DEPARTMENTS

Inside Business

9 Electronics 1995: The hard and the soft of it

My View

113 On advertising. And whining

Company Index

114 Companies covered in this issue

Advertiser Index

115 Advertisers covered in this issue

Viewpoint

116 Wanted: Thoughtful and provocative ideas

EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: John Russell

Managing Editors: H. Garrett DeYoung, Hugh G. Willett

Senior Editors: Linda Stallmann (Financial), Rick Whiting, Elizabeth B. Baatz, Peter L. Burrows

Associate Editor: David Webb

Assistant Editor: Barbara Jorgensen

Copy Editor: Elaine M. Cummings

Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker

Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)

Consulting Editors: Alberto Socolovsky, Lewis H. Young

Senior Production Editor: Karen J. Covey

Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach

Associate Art Director: Elizabeth Zisa

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing: John R. Sanders

Production Supervisor: Andrew A. Jantz

Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ken Evans
44 Cook Street, Denver, CO 80206
(303) 388-4511

Total Circulation: 77,804

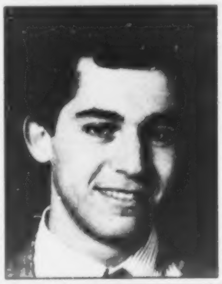
REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

INSIDE BUSINESS

Electronics 1995: The hard and the soft of it

If you're not convinced that electronics manufacturers are seeing their corporate futures in software, consider this: By 1995, Schlumberger Technologies predicts that only 30% of its engineering staff will be working in hardware while 70% will be in software. Just two years ago, the hardware-to-software engineering ratio was 60:40 in favor of hardware.



Senior editor Peter Burrows

Schlumberger's automated test equipment (ATE) operation provides a fascinating window into the hardware-versus-software debate: While ATE is about as hardware-oriented a field as there is, the smart money is clearly on software innovation. Senior editor Peter Burrows reports that Schlumberger invested $3 million last year in its Austin-based computer science laboratory, where software engineers use the latest supercomputer to employ technology they believe will differentiate Schlumberger from the rest of the ATE world. Some of that technology focuses on an improved interface for equipment users, some on the engineering of software development itself. Writing software, after all, imposes new and stern demands for quality and reliability.

As Schlumberger has learned, and as other companies would be wise to remember, new manufacturing technology isn't the only challenge in making software development pay. Salespeople must learn to treat software as a primary asset, not as an add-on incentive to boost hardware sales. Manufacturers must choose with care the software they sell, and they must decide how to price systems that incorporate their new software in a way that reflects added value without turning off old customers.

Meanwhile, are we to consign all hardware manufacturing to a downward spiral of commodity pricing that puts U.S. players out of the game? Not necessarily, reports West Coast managing editor Hugh Willett. U.S. executives are finding there's room to compete even in the low-end chip, board, and PC markets. The trick, they say, is to increase efficiency in operations and manufacturing while differentiating the product in terms of power, service and support, and interconnectivity. Alas, it's mostly the larger companies that have the resources to compete in the large-scale manufacture of "commodity" chips and systems while making heavy R&D investment in high-end products.

ELECTRONIC BUSINESS* (ISSN 0163-6197, GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer. Frank Sibley, Executive Vice President. Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance. Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS* is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS*, PO Box 173377, Denver, CO 80217-3377.**
ELECTRONIC BUSINESS* copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer.
Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year. $140 air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

COMPENSATION

End of the stock-options party?

Why corporations like executive stock options

(Option: 10,000 shares at $15 per share)

	When granted	When vested	When exercised
Market price	$15	$25	$35
Expense to corporation	$0	$0	$0
Benefit to corporation	$0	$0	$150,000 Equity contribution $200,000 Tax deduction

Under current accounting practices, offering stock options doesn't cost companies anything, and they add benefit when exercised. The new FASB plan would change that.

THE FINANCIAL Accounting Standards Board (FASB) is again proposing that the estimated value of unexercised stock options be treated as an operating expense. High-tech start-ups claim the proposal is a disaster: Not only will it discourage use of stock options to entice employees away from larger corporations, but treating stock options as an expense instead of as a potential tax deduction will hit everyone's bottom line. The FASB plan, S1198, is now in bill form and in Congressional committee.

Under current accounting standards, cash salaries are deducted from company earnings on the earnings statement and claimed as a tax deduction. When an employee exercises a stock option, the company does not show an expense on its statement but still deducts the expense. Stock-option plans currently are approved by a vote of stockholders and reported in footnotes of financial reports.

The proposal comes amid escalating sound and fury over excessive executive compensation, in which stock-option plans play a large part. "There is no other form of CEO pay that is a deduction on a corporations's tax return but not an expense on the corporate books," says Sen. Carl Levin (D-Mich.), who has held two hearings on executive compensation. "That's why I call it 'stealth compensation.' "

High-tech CEOs call it something else, such as important, crucial, and essential to Silicon Valley's entrepreneurial culture. If the FASB plan were implemented, says George Sollman, president and CEO of San Jose-based Centigram Communications Corp., small and midsize companies would have to abandon or significantly cut the stock options they use to entice employees away from larger corporations that can pay higher salaries. Silicon Valley would become Death Valley, according to the proposal's critics. "The first employees at Centigram came from established corporations such as IBM, Xerox, and Rolm," Sollman told the Senate Subcommittee on Oversight of Government Management. "Without stock options, we could not have attracted those key people."

High-tech companies tend to offer stock options to an unusually large number of employees. All 240 employees at Centigram, for example, are eligible for stock options. "So a much higher percentage of [Centigram's] total compensation package would be affected by the new standard," says Sollman.

Actually, the proposal is a clone of the FASB's 1986 attempt to impose the same reporting accounting requirements on stock options. Outraged executives raised a ruckus then, too, leaving the FASB's plan dead in the water. The executives' cause was aided by an American Electronics Association survey of 12 companies that found the companies' reportable profits would have been cut by an average of 43.5%.

What wasn't happening in 1986, however, was the level of protest that is presently being raised by John Q. Public. Given the recession, unemployment, and election-year politics, the proposal now stands a better chance of being adopted. Furthermore, a Senate source says Levin's position is being supported all across the business community. So no matter how just the electronics and computer industries believe their cause to be, they've got some hard travelling ahead.

—*Willie Schatz in Washington, D.C.*

INTERNATIONAL

Slow Japanese market wallops U.S. imports

TOKYO'S free-falling stock market signals rough times ahead for Japanese companies, many of which have responded by cutting back on new products and suppliers. That's bad news for U.S. electronics exporters, whose sales in Japan have fallen even faster than that nation's shipments of electronics goods.

Japan's downturn hits U.S. suppliers hardest

Japanese shipments	Nov. 1991 (% change from year ago)	Nov. 1991 (% change from previous month)
Integrated circuits	4.4%	5.0%
Computers and peripherals	-5.8%	7.5%
U.S. imports to Japan		
Integrated circuits	1.2%	-13.8%
Computers and peripherals	-7.7%	1.9%

Source: MITI

Last month, the Nikkei stock average slipped below 20,000 for the first time in more than five years. The slump reportedly has dampened lending by the nation's banks, which are heavily invested in the stock market. Although the economy's downturn is relatively modest—about .05% during the fourth quarter of 1991—uncertainty about the next few quarters has some managers visibly nervous. "The Japanese market started to drop only in October, so it hasn't reached bottom yet," says Kunihiro Yakuo, general manager of the microproducts division of Dai Nippon Printing Co. in Tokyo.

With sales, profits, and capital spending on the skids, everyone in Japan is hurting. Newcomers and outsiders, however, seem to be getting the worst of it. The hunker-down mentality means less willingness to take chances on new suppliers, fewer new product introductions (and hence fewer opportunities for new imported components), and more in-house production to keep workers busy. In addition, falling earnings mean new efforts to squeeze price concessions from suppliers and to shift production to higher value-added goods. "We don't think things will pick up for six months to a year at best," warns Katsunori Kubo, manager of corporate planning at wafer maker Shin-Etsu Handotai Co. in Tokyo.

All of that translates to fewer design-in programs that U.S. chip makers had hoped would boost sales. Although Japan's Ministry of International Trade and Industry (MITI) still pressures Japanese companies to do more, the cutback in new products will inevitably take a heavy toll. "[Japanese companies] are prioritizing foreign projects, but volume for design-in is much less," notes Takashi Takagaki, senior manager of Advanced Micro Devices (AMD) Japan's customer service center in Tokyo. Rather than touting its technology, Sunnyvale, Calif.-based AMD is working to maintain its Japanese sales by increased emphasis on quality, support services, and technical support.

Semiconductors and computers, each running more than $100 million a month, are by far the biggest categories of imports from the United States, followed by disk drives at about $35 million a month; all other categories run less than $15 million a month. Some of these smaller markets saw big percentage increases despite the general slowdown, however. Imports of color TVs from Japanese plants in the U.S. surged ninefold in November 1991 over 1990, to $5 million, while printed circuit boards climbed 7% to $12 million. Imports of printers jumped 46%, to $13 million.

Low-cost electronics imports from other parts of Asia are booming, however, although total volumes remain small. ICs from Korea were up 37% in November from the year before (to $31 million), those from Taiwan rose 16% (to $10 million), and those from newly developing Asian economies climbed 15% (to $48 million). Computer imports from the latter suppliers were up 46%, to $18 million.

The trade figures track *all* electronic imports to Japan, and thus include some production from Japanese-owned plants abroad. The data does not include the sales of large U.S. companies that manufacture in Japan.

—Paula Doe in Tokyo

TELECOMMUNICATIONS

Telecom could be the Bay State's high-tech savior

CAN MASSACHUSETTS' Route 128 Technology Highway make the transition from minicomputers to telecommunications?

Even before the recession walloped the Northeast, Route 128's minicomputer makers were being battered by the widespread acceptance of networked PCs. In 1991, the state's unemployment hit its highest level since World War II, and high-tech employment declined 5%.

Hope, however, is not lost, says a recent study by the Bank of Boston—it resides in Massachusetts' technologically advanced telecommunications industry. "Our analysis suggests that this industry should continue on a growth path during the rest of the decade," says the bank's chief economist Wayne M. Ayers.

His optimism is based on several facts:

- Massachusetts accounts for 11% of the nation's communications shipments and has the nation's highest concentration of these companies;
- The state's high employment declined in 1991, but communications equipment employment held steady, and companies with under 1,000 employees added 430 jobs last year—a 4.1% increase;
- Twenty-six telecom companies, or 19% of all the telecom companies headquartered in the Bay State, were started in the past three years, despite the recession;
- At the Massachusetts Institute of Technology, 15% of the licensing

agreements completed in 1991 were in the communications field, many in still emerging, innovative niches.

An excellent supplier network, complementary computer and software industries, and huge export potential makes Ayers's optimism seem well founded. While the Northeast will no doubt lag the rest of the nation in an economic rebound, telecom offers hope for the region's future.

—*E. B. Baatz*

MARKETS

Customer perception could hamper pen-based market

THE MARKET FOR pen-based computer systems is evolving at an unprecedented rapid pace, but the systems' near-term fate still isn't clear. Market projections are highly optimistic: BIS Strategic Decisions expects unit shipments to grow from 160,000 this year to 146 million by 1995. There are a few things that need to happen first, though, such as operating system availability and education of the potential user base.

Two of the three major pen-based operating systems for the broad business applications market are now unavailable to users. Microsoft's Windows for Pen Computing and Go Corp.'s long-awaited PenPoint operating systems are the two biggest expected catalysts for the pen market, but both have been delayed well beyond initial target shipping dates.

Users can get proprietary, niche-oriented operating systems from Grid Systems, Momenta, NCR, and Pi Systems, but at the risk of being tied to a limited number of applications. Other hardware vendors such as Samsung won't deliver volumes of their tablets until Go's and Microsoft's products become available.

Regardless of operating system availability, developers and users still perceive pen systems as virtually useless without handwriting character recognition capabilities. That is not necessarily true, and vendors have been taking pains to educate the market. They have a long way to go to convince most users they don't need handwriting recognition for now. The real point, vendors say, is using the pen as an input device as opposed to a keyboard or mouse, not whether the data is presented in script.

"This is not an evolution of the PC market," contends Go chairman Gerald Kaplan. "It is revolutionary, and we've got to educate the user/developer community as a standalone entity from the PC world. As long as people expect us to do what PC's can do and more, we'll never fully exploit the pen's true potential."

—*David Webb in San Jose*

COMPUTERS

Big companies to squeeze info systems budgets again

Who's spending on info technology

(Projected 1992 information systems budget by industry)

Industry	1992 spending plans: Growth from 1991	1992 spending plans: As % of revenue
Media & entertainment	7.5%	2.8%
Pharmaceuticals & medical products	7.3	2.5
Transportation services	7.3	2.1
Consumer products	6.4	1.5
Insurance	5.6	4.2
Banks & financial services	5.3	0.8*
Retail, restaurants, & wholesale	2.9	1.1
Telecommunications	2.4	8.6
Automotive	1.4	1.0
Computers & electronics	1.1	3.2
Utilities	1.1	1.7
Mining & metals	-0.3	1.4
Oil & energy	-2.2	1.0
Aerospace	-7.1	4.4

Based on an Oct. 1991 survey of 444 large (greater than $250 million) companies

* As % share of assets

Source: CSC Index

SALES OF computers, software, and systems to large companies have been harder to come by during the recession, and there's no end in sight to the squeeze in 1992. Information systems (IS) budgets have been cut again this year, according to a CSC Index Corp. survey of 444 senior IS executives in industries as diverse as banking, manufacturing, and media.

The 1991 survey predicts budgets will rise only 3.5% in 1992, after a 5.3% predicted gain in 1991 and a 6.9% increase in 1990.

Even the computer, software, and electronics industry forecasts only a 1.1% increase in IS spending in 1992, after a 10.5% projected budget jump the year before. Still, 71% of the 23 large North American companies studied say they will make significant information technology investments to upgrade order processing; another 63% will invest in manufacturing; and 58% in product delivery and logistics. Reengineering of key business processes, with attention to customers, appears to be the motivating force for whatever small budget increases electronics companies have planned in the coming year.

—*E. B. Baatz*

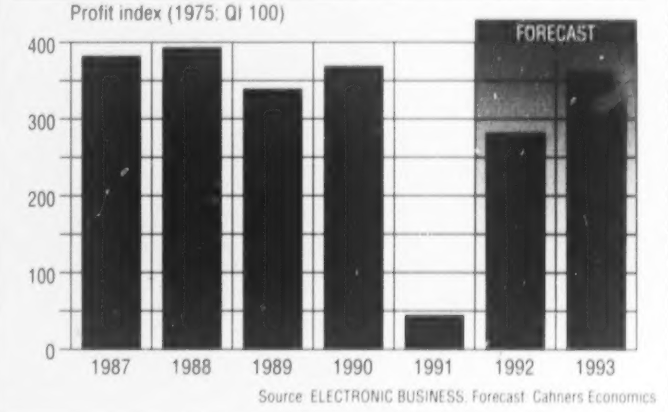
HUMAN RESOURCES

Tough stance on visas could mean more U.S. jobs

IT'S GOING TO GET easier for a U.S. engineer or manager to land a job with a Japanese-owned U.S. subsidiary, even if he or she is competing with a Japanese applicant.

The reason is that U.S. immigration officials are getting stingy on handing out visas. Nearly half of all foreigners in the U.S. on manager's

Profits crash in '91, to rebound in '92



Source: ELECTRONIC BUSINESS. Forecast: Cahners Economics

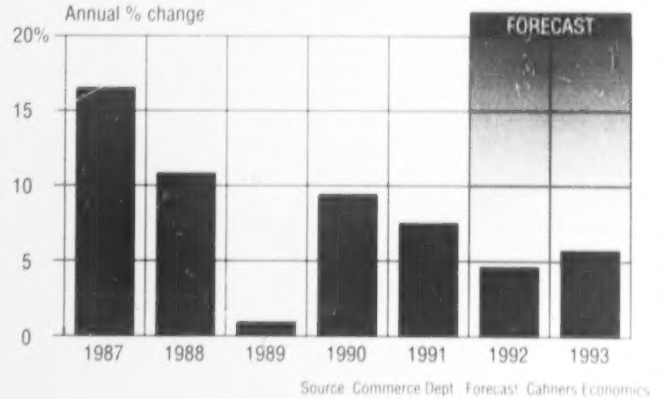
Gloomy outlook for electronics employees

Annual % change in employment by industry segment

	1990	1991	FORECAST 1992	FORECAST 1993
Semiconductors and components	-5.2%	-5.2%	-2.0%	0.1%
Consumer electronics	-4.4	-5.2	1.7	0.3
Communications	-3.4	-5.5	-1.1	-0.5
Computers and office equipment	-4.3	-4.6	-4.2	-3.4
Instruments	-2.2	-3.6	-2.0	0.5

Source: Labor Dept.; Forecast: Cahners Economics

Medical electronics shipments growth slows



Source: Commerce Dept.; Forecast: Cahners Economics

Lower interest rates will revive revenue growth

PROFITS

The forecast: Electronics revenue will grow 3% in 1992 and 5.3% in 1993. Restructuring will continue, but will be in the later, less expensive stage, which will help profits. **Recent history:** For the first time, the ELECTRONIC BUSINESS Revenue Index declined 0.3% in 1991. Add in costly restructuring charges, and the result was the worst profits performance of the past 16 years; the ELECTRONIC BUSINESS Profit Index plunged 88% in 1991.

EMPLOYMENT

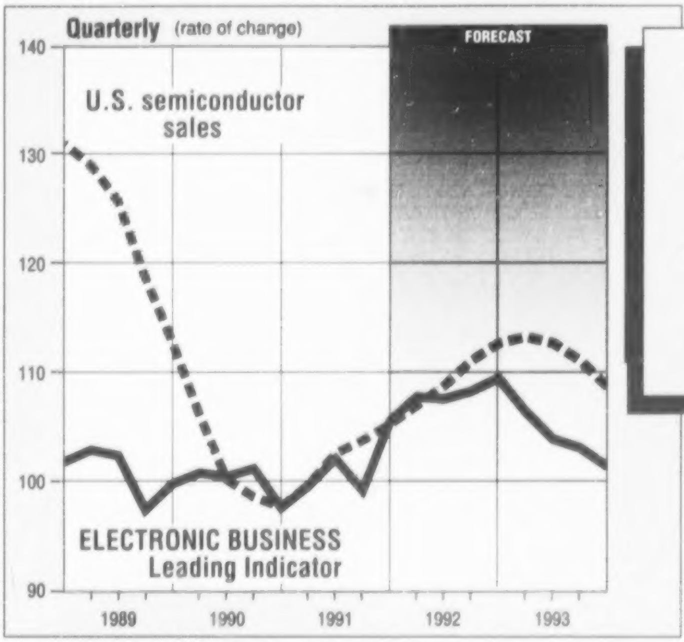
The forecast: Manufacturers will continue scaling back in 1992. Cahners Economics forecasts electronics employment will fall 2.2% again in 1992 to 2.1 million jobs. The software industry, not represented in the manufacturing job count, will continue to pick up the slack. **Recent history:** U.S. electronics factories squeezed out a 0.8% gain in output last year, but employment dropped 4.5%, much steeper than our original forecast of a 2% decline. The semiconductor/component (losing 34,000 jobs) and instrument industries (losing 31,000) experienced the most severe cuts.

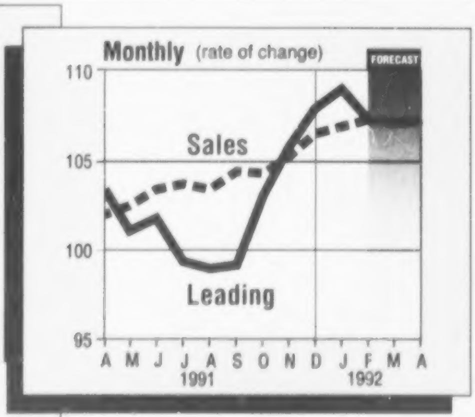
MEDICAL ELECTRONICS

The forecast: After climbing 7.5% in 1991, shipments of medical instruments will grow 4.6% in 1992 and 5.7% in 1993. Cuts in Medicare and employer-provided health insurance will dampen growth at home, but demand from abroad—where per capita medical care expenditures are still far below the U.S.—will grow strongly. **Recent history:** Growth in orders for medical instruments slowed to 4.7% in 1991 after averaging 9.3% over the past 10 years. Backlogs also declined 5.3%, falling for the first time since 1976.

J. Farrell and J. Handelman-Sagan

ELECTRONIC BUSINESS Leading Indicator



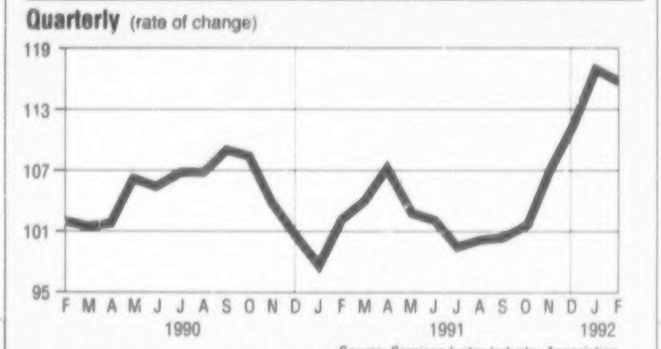


Leading Indicator up, up, and away?

THE ECONOMY may have staggered into 1992, but the leading electronics markets leaped into the new year. From its most recent low of 98.9 in August 1991, the ELECTRONIC BUSINESS Leading Indicator (EBLI) jumped to 108.9 in January and remained high, at 107.2 in February. Recent growth in semiconductor bookings is further evidence of the underlying strength of the EBLI's rise. The latest surge is expected to subside during the next five months, then turn upward again in August to reach a peak of 109.9 in December. Look for market growth in the electronics industry to peak in 1993.

—*John Farrell*

Chip orders provide foundation for optimism



Source: Semiconductor Industry Association

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Feb.)	107.2	108.9	100.2	101.5
U.S. semiconductor bookings ($ millions, 3-month average, Feb.)	$1,518	$1,447	$1,350	$1,311
Weekly hours of semiconductor production workers (monthly average, Jan.)	42.2	42.4	39.9	41.1
Electronic components lead time index (1977 = 100, Feb.)	88.0	83.6	108.0	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, Feb.)	91.5	83.7	70.3	68.5
Change in electronic components inventories ($ millions, SA, Jan.)	-$99	-$147	$5	-$53
Contracts and orders for plant and equipment ($ billions, SA, Jan.)	$34.4	$31.7	$37.7	$35.0

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100

Finding the right partner for the systems integration hustle

It's a $20 billion business growing 20% a year, but integrators' desire to be hardware independent make them fickle allies for OEMs

By Rick Whiting

Executives of computer manufacturers are eagerly searching for dance partners at the booming systems integration party. OEMs must learn some pretty intricate steps if they want to avoid tripping—they have to pick partners with an edge in strong vertical markets and accept the fact that their partner today could be their competitor tomorrow and a partner again next week. It's that kind of business.

Systems integration already accounts for $20 billion to $25 billion in annual sales, or about 15% of all user spending for information technology products and services, according to market researcher International Data Corp. in Framingham, Mass. While the computer industry as a whole is in the doldrums, IDC notes that systems integration sales are growing at about 20% a year and will reach $58.6 billion in 1996. G2 Research Inc. in Mountain View, Calif., is even more optimistic—it predicts that the systems integration market will reach $70 billion in 1995.

"Systems integration has become a key part of our business," Ken Olsen, president of Digital Equipment Corp. in Maynard, Mass., said at the company's annual meeting in November. Systems integration accounted for about $1.1 billion of Digital Equipment Corp.'s $13.9 billion sales in fiscal 1991 and is growing at 25% to 30% a year. "This is the fastest-growing part of the computer business," according to Olsen.

Everyone seems to have a slightly different definition of what it takes to make a systems integrator. "Some are just glorified value-added resellers," says J. P. Richard, principal consultant with market research firm Input Inc. in Vienna, Va. The general consensus is that systems integrators deliver a complete solution to customers by combining expertise in hardware, software, and communications technologies from multiple suppliers with knowledge about specific industries and business disciplines. "We try to understand in depth the details of [the customer's] business," explains Paul Cosgrave, managing partner for integration service and technology for the Americas at Arthur Andersen & Co.'s Andersen Consulting Division in Chicago, one of the largest systems integrators. "We have tremendous areas of focused, industry-specific expertise."

Systems integrators assume full financial and technical responsibility for projects, managing subcontractors, and serving as the single point of contact for the customer. Most contracts are awarded on a fixed-price basis, says George Newman, IDC's director of services research.

Several factors are behind the increased demand for systems integration services: the growing complexity of computers, the increasingly larger computer networks, and the move toward open standards that creates multivendor networks. "The systems integrator has taken on a stronger role as computer vendors begin moving toward open systems and away from proprietary technology," says Mark Fowler, president and chief executive of Systech Corp., a $22 million company in San Diego that relies on systems integrators as a sales channel for its communications subsystems.

FURTHERMORE, major corporations that are overhauling their computer networks and trimming management information system staff create a greater demand for systems integration services, notes James Perkins, a consultant with market research firm G2. Adds Vernon Ellis, European managing partner of Andersen Consulting in London, "The fundamental challenge is to help companies restructure and re-engineer themselves."

Increased demand by corporate users for comprehensive technology service, the heightened complexity of technology, and the user preference for open systems represent lost opportunities for vendors that fail to recognize integrators as potential resellers or sales partners. "Every equipment vendor has to have some kind of systems integration channel," says Input's Richard.

Hewlett-Packard Co., for example, is currently selling more than $100 million worth of products through such systems integrators as Electronic Data Systems Corp. and Andersen Consulting, says Ronald Lim, systems integration channel marketing manager. Usually HP supplies only computers and related products to systems integrators but on occasion serves as a subcontractor when a project calls for special knowledge of HP products.

DEC plays both sides of the game, selling its products to other integrators and serving as a systems integrator itself. Through its own operation, Digital Equipment Corp. snagged PC networking contracts from the U.S. Navy and United Technologies Corp. late last year valued at $140 million and $80 million, respectively. In a subcontractor role, DEC is working with The Boeing Co. in Seattle on a $150 million contract to create a network of 28,000 computers at 4,700 U.S. Army Reserve and National Guard sites.

What is a systems integrator?

Knowledge of a variety of technical and business disciplines is required to succeed as a systems integrator

- Mainframe, minicomputer, and PCs from multiple vendors
- Applications software
- Telecommunications
- Computer networking
- Data communications expertise
- Backround in specific industries

Source: ELECTRONIC BUSINESS

Despite the increased demand for systems integration, the market is not hassle-free for computer makers, software developers, and manufacturers of other products. Eager to supply whatever product type or brand name their customers want, systems integrators are notoriously fickle when it comes to supplier loyalty. And the up-front investment required for a vendor to get on a systems integrator's "buy" list does not guarantee rewards.

The giants of the systems integration industry come from various backgrounds: those that have been systems integrators from the start, including EDS, Computer Sciences Corp. (CSC), Computer Task Group, and American Management Systems; aerospace companies such as Boeing that, having integrated their own sprawling computer networks, found there was a market to do the same for others; Andersen, Coopers & Lybrand, Price Waterhouse, and other accounting firms; and computer makers, particularly IBM and DEC, that figured out that simply dropping new computers off at customers' loading docks was leaving money on the table. IDC calculates that IBM is the leading systems integrator, with an 8% share of the market in 1990, followed by DEC with a 5.7% share and Andersen Consulting and EDS each with a 4.6% share of the market.

Many observers say the market is becoming glutted with aspiring systems integrators. Cap Gemini Sogeti in France, the leading systems integrator in Europe, is now making a major push into the U.S. market. Software companies such as Microsoft, Lotus Development, and Oracle have jumped into the systems integration game. As hardware and software profit margins fall, more companies are arming themselves with application software and screwdrivers and calling themselves systems integrators. "It's a buzzword," says IDC's Newman. The "massive restructuring going on within *Fortune* 1000 companies," however, will provide enough business for systems integrators to forestall an industry bloodbath, says G2's Perkins.

GENERALLY the major systems integrators cover all markets, although each segment has its leaders. IBM, for example, is the premier supplier of systems integration services to the banking, finance, and state and local government sectors in the U.S., according to G2. Arthur Andersen and EDS are the major players in the manufacturing arena. "We can bring expertise to a manufacturer as a systems integrator that's been on the factory floor," claims Kevin Curry, EDS director of corporate market analysis, referring to his company's experience with the manufacturing operations of its parent, General Motors Corp.

The federal government, especially the Department of Defense, has provided systems integrators with some of their biggest contracts in the past. However, commercial markets are larger and growing faster: Input estimates that in the U.S., commercial systems integration contracts in 1991 were valued at $4.4 billion, compared with $3.3

billion for the federal government. By 1996 commercial contracts will total $10.5 billion and federal government work $6.9 billion.

Smaller integrators make a living by concentrating on niches. Despite its generic name, System Integrators Inc. in Sacramento focuses exclusively on designing and installing computer networks at newspapers ranging from *The Washington Post* to the *Tiroler Tageszeitung* in Innsbruck, Austria. Aurora Systems Inc., an Acton, Mass.-based systems integrator, specializes in linking computer and telecommunications networks for telephone-call processing; and ERI of Hauppauge, N.Y., offers full systems integration services at the departmental level, picking up the $500,000 or $1 million contracts that EDS and other giants consider small change.

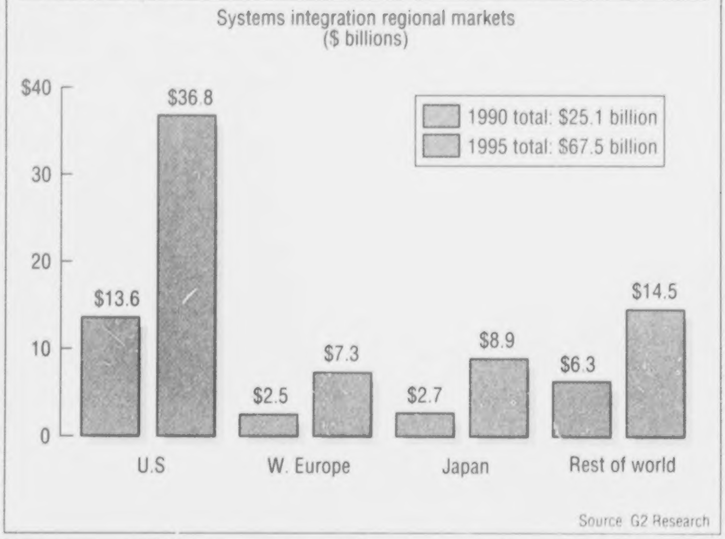
Faced with the fragmented state of the systems integration market, OEMs have pursued a variety of strategies to pump their wares through this lucrative channel. Some simply use integrators as resellers while others team up with systems integrators—with either party serving as the prime contractor or subcontractor. Others are themselves systems integrators. Many juggle all those roles.

Compaq, NCR, and Pyramid Technology, all in the early stages of forming partnerships with systems integrators, represent three popular approaches to entering the business. Compaq launched its program last October and recently tapped EDS as its first partner, as it concentrates on the bigger players. NCR is looking for a select group of small but dominant niche integrators, while Pyramid offers its own integration services and partners with a few niche companies.

NCR's Systems Integrator Alliances group gives systems integrators a single point of contact within the Dayton, Ohio, company's U.S. marketing organization. In November NCR inked a $2 million deal to supply its System 3000 and pen-based computers to Information Decisions Inc., an Indianapolis-based systems integrator specializing in manufacturing, financial, and state and local government projects.

NCR plans to ally itself with, at most, 10 to 12 such integrators, says Mike Ruffolo, director of NCR's systems integrator alliances channel. "We don't feel we need that many relationships to do a good job," he says. "You can cover a lot of territory if you have good alliances." NCR is using three criteria in its search for partners: Ability to provide custom solutions for buyers, experience at project management, and willingness to take on the role of prime contractor.

Systems integration services in demand worldwide



Source: G2 Research

BY TEAMING WITH systems integrators with niche expertise, Pyramid is able to go after sales it had to pass up before, even though the Mountain View, Calif., computer vendor runs its own systems integration operation. Pyramid recently established an alliance with CGS Computer Associates Inc. in Iselin, N.J., which targets systems integration jobs involving financial applications and imaging technology. "This is the first of a limited number of teaming relationships we're going to form to address certain vertical markets," says Bob Wardell, director of Pyramid's Professional Services unit.

Pyramid is not alone in focusing on systems integrators in specific vertical markets. "If you target the right niche, there's plenty of activity," says Chris Fairclough, president of Dublin, Ireland-based Mentec Computer Systems Ltd., which markets board-level computers to integrators in telecommunications, manufacturing, and utility markets. Revenue from systems integration projects within the manufacturing sector alone will reach $7.7 billion by 1996, predicts G2, and $4 billion from utility companies. Systems integration spending by health care, telecommunications, and insurance companies are each expected to exceed $2.5 billion by then.

Not surprisingly, systems integrators choose their suppliers either on the basis of price or technology, says W. Neil Armentrout, marketing senior vice president of QMS Inc. in Mobile, Ala., which sells between $4 million and $5 million in laser printers through integrators. Some systems integrators, including EDS and

Andersen Consulting, look for the lowest cost products that meet customer specifications, according to Armentrout. Others, including CSC in El Segundo, Calif., select their suppliers on the basis of product sophistication to sell more advanced technology to customers.

Hardware suppliers can make themselves more attractive to systems integrators by providing such incentives as support hotlines and design teams dedicated to work with integrators, says Input's Richard. "They must find creative ways to differentiate themselves," he says.

NCR, for example, maintains dedicated systems integration resources in both its headquarters and in field offices. The computer maker's own sales force develops joint-marketing initiatives with integrators that target vertical markets. Some computer makers, IBM among them, offer systems integrators what Aurora Systems CEO Paul M. Gasparro calls "influence fees" of up to 10% of a contract's value if the integrator's software helps to close a sale. "One of the best ways to start a relationship with a systems integrator is to use your own direct sales force to generate a lead and then approach a systems integrator with a proposal," says G2's Perkins.

Getting onto a systems integrator's list of subcontractors by no means guarantees a continuous flow of orders. To offer their customers as many choices as possible, systems integrators prefer to be hardware independent rather than standardize on a few platforms. EDS, for example, has contracts with more than 6,500 suppliers. "We are truly the best open hardware vendor because we don't make hardware," says Arthur Andersen's Cosgrave. "Consultants are hired for a lot of reasons, but one is objectivity. That's hard to be if you've got a vested stake in the technology."

Gaining the attention and loyalty of a systems integrator takes work. "It takes time and energy to understand how these companies work," says Neil McGowan, director of integration and engineering services at Tandem Computers Inc. in Cupertino, Calif. However, OEMs should not allow themselves to be sucked too deeply into supporting integrators. IDC's Newman says suppliers must take care to avoid "overcommitting resources in relation to the potential return from the channel."

Given the continuing plunge in profit margins on computer hardware along with systems integrators' unwillingness to lock themselves into any one vendor's platform, fewer systems integrators today appear to be buying computers and reselling them as part of a total solution. Instead, they are calling in computer makers to serve as subcontractors, which suggests that manufacturers of computers and other equipment should view systems integrators less as product resellers and more as marketing partners.

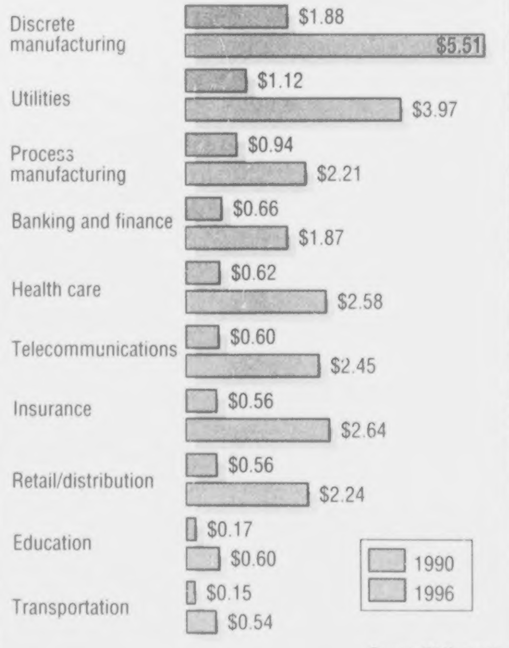
Indeed, the shifts in the systems integration business reflects the mercenary nature of the market: Today's collaborator could be tomorrow's competitor. Dallas-based EDS, for example, is the largest buyer of IBM products outside of the federal government, even though EDS and IBM compete head-to-head for systems integration contracts. "That's the nature of the business," says Newman. "It's done on a deal-by-deal basis."

Another fact of life in the market is the not surprising tendency of OEMS to push their own gear when wearing their systems integration hats. The majority of gear they sell will be their own, though they down pedal that aspect of their service in pitches to customers. IBM tries to reassure potential customers about its objectivity. "It may surprise you, but around 40% of a typical IBM project goes to non-IBM sources," the company noted in a recent advertising campaign. A DEC spokesman notes that it resells gear from Tandy, Apple, Intel, Olivetti—even IBM—and provides service and support for some 10,000 products from 1,000 vendors. "If [customers] want a competing product that will work equally well, then that's what they will get," says the DEC spokesman. ☐

Additional reporting by Barbara N. Berkman in London

Hot vertical markets for systems integration

Spending by *Fortune* 1000 companies by vertical markets ($ billions)



Source: G2 Research

A clash of giants shakes the low-end workstation market

Sun, DEC, IBM, and HP are in a bruising battle for market share as they push low-end workstations into commercial areas dominated by PCs

By Rick Whiting

According to the rules of leapfrog, it should be Sun Microsystems Inc.'s turn to make the next price/performance jump. IBM, Hewlett-Packard, and Digital Equipment Corp. have in recent months unleashed new workstations with price tags in the $4,000 to $6,000 range. Mountain View, Calif.-based Sun, once considered the leader at the low end of the workstation market, now finds its prices in the middle of the pack and is expected to fight back shortly with new lower-priced products. "The whole market has essentially changed in the last few months," says Tom Kucharvy, president of Summit Strategies Inc., a market research and consulting firm in Boston.

Despite the recession, the workstation market grew some 15% last year, to $8.8 billion, according to market researcher Dataquest Inc. in San Jose. It predicts that workstation sales will increase around 25% to $10.9 billion this year, although those estimates will likely be revised downward if the recession drags on. Reflecting the increasing number of low-end workstations sold for less than $6,000, however, the market research firm expects total unit shipments to climb 53% to 790,500. That volume surge will squeeze the average price for a workstation from $16,750 last year to around $13,800. However, workstations with price tags between $15,000 and $20,000 remain the single largest segment of vendors' hardware revenue, Dataquest says.

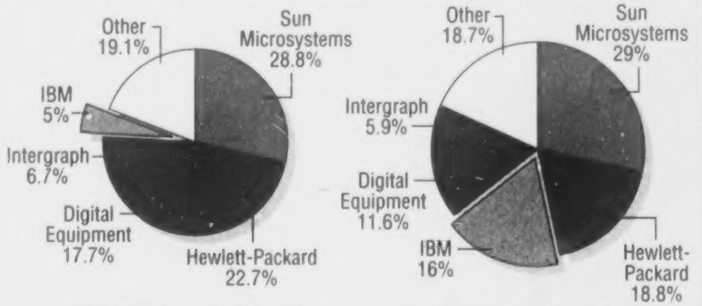
And despite falling prices, analysts and customers say workstations still have a long way to go before they become as commodity-like as personal computers. Unlike PCs, which are based on a single operating system (DOS) and microprocessor family (the 80x86 from Intel Corp. in Santa Clara, Calif.), workstation vendors can still differentiate their computers by using different microprocessors, software, graphics capabilities, and other features. Although profit margins are tightening at the low end, no one foresees the kind of margin collapse among workstation manufacturers that hit PC vendors last year.

The entry-level market is critical for workstation vendors, however. Low-priced units provide DEC, Sun, and other companies with a foot in the door to new accounts. Even more important, the under-$10,000 machines are the vehicles that most workstation suppliers ride to penetrate the potentially huge commercial market. While scientists and engineers require the power and graphics capabilities of a $20,000 workstation, commercial users are buying sub-$10,000 workstations as alternatives to PCs. "That's the hot area," says Laura Segervall, senior industry analyst at Dataquest.

For several years, vendors have been selling workstations to securities traders, publishers, and other commercial customers who require extra number-crunching power, multitasking functionality, sophisticated graphics, and advanced networking capabilities, but manufacturers see those initial marketing forays as just testing the waters. "This is the year

IBM's gain is DEC's and HP's loss

Worldwide workstation market share based on factory revenue



Total 1990 market: $7.7 billion   Total 1991 market: $8.8 billion

Source: Dataquest Inc.

that workstations begin to make the leap into the general commercial market," predicts Gary Eichhorn, general manager of HP's Workstation Business Unit in Palo Alto, Calif.

Workstation "price points seem to be sliding in the right direction," says Dave Bennett, Dunkin' Donuts' MIS director

Dave Bradley

International Data Corp. in Framingham, Mass., forecasts sales of commercial workstations at 720,000 units, or 35% of the total market by 1995. Sun has had the most success among workstation vendors selling to commercial accounts—it lists customers such as Northwest Airlines, Dunkin' Donuts, Healthcare Affiliated Services, and Yale University. The company estimates that about 30% of its sales are to commercial customers, with the balance sold for scientific and technical use. IDC expects that by 1994 one-half of Sun's workstations will be sold for commercial applications.

Dunkin' Donuts Inc. in Randolph, Mass., may be typical of the corporate interest and use of workstations. Its handful of Sun Sparcstations have brought productivity benefits to in-house systems developers and database administrators. The question MIS director Dave Bennet is trying to resolve is at what price point workstations make economic sense for the more routine office chores done by its 400 personal computers. "The price points do seem to be sliding in the right direction," he says.

DEC WAS THE FIRST workstation vendor to fire a volley in the latest battle over the low end when it began marketing additions to its DECstation 5000 line of workstations in December. The Maynard, Mass., company's lineup includes the Model 20 and Model 25, with entry prices of $3,995 and $4,995, respectively, giving the company bragging rights to having the lowest priced RISC workstation on the market. The DECstations are based on the R3000 RISC chips from Mips Computer Systems Inc. in Mountain View, Calif., and, like other vendors that rely on the Mips microprocessors, DEC has been hurt by Mips's delay in getting out its next-generation R4000 chip. The DECstation is relatively low-powered compared with entry-level workstations from its competitors (see table, page TK). DEC also markets the VAXstation line of workstations based on its proprietary VAX technology.

The DECstations' selling point is that they are more upgradeable than competing systems and will not become obsolete within six months, contends Domenic LaCava, vice president of DEC's Unix-based Software and Systems group. The DECstations offer the option of installing the R4000 chip when it becomes available, for example, and the Model 20 includes two TurboChannel slots for adding peripheral devices and other hardware. "Customers are buying the systems because they see a future for them," LaCava claims.

The future isn't clear, though. DEC is expected to begin marketing by the end of the year workstations based on its own RISC microprocessor known as "Alpha." Because DEC also promises to continue marketing workstations using the Mips chip, the company faces the challenge of supporting two different workstation platforms (three, if it continues the VAXstation line) and risks creating confusion among buyers, says Nancy Battey, director of workstation research at IDC.

Early this year, IBM retaliated in a bid to accelerate the market momentum gathered two years ago with the debut of its RS/6000 workstations. It unveiled, among other additions to the RS/6000 line, the PowerStation 220 with a bottom-line price tag of $6,345. That system could account for 20% to 25% of the company's workstation sales this year, according to IBM. The system is based on a single-chip implementation of IBM's RISC processor technology, while earlier models required a CPU with from seven to nine chips. The PowerStation 220 is still priced higher than entry-level offerings from HP, DEC, and Sun, but analysts say IBM has focused on providing a well-rounded system rather than the lowest price or the most impressive price/performance ratio.

IBM's workstation strategy has served it well. From the negligible market share the company held in the late 1980s with its failed RT, IBM snagged 16% of the market in 1991 with the RS/6000, according to Dataquest, surpassing DEC and capturing third place behind HP and Sun. "We're still not the market leader, but we're coming up fast," boasts Bill Filip, president of IBM's Advanced Workstation Division.

RS/6000 sales reached $1 billion in the line's first year, company officials claim, including software and other add-on products. IBM executives have been more closed-mouthed about specific sales figures since then, but they say the company achieved its goal of a 50% to 70% sales increase in 1991 and is shooting for another 50% increase this year. That would put RS/6000 sales well over the $2 billion mark. Despite the gains, however, IBM's efforts were handicapped by the lack of a low-end workstation—its cheapest RS/6000 was priced at nearly $14,000—until its recent announcement.

HP also introduced new low-end products in January to regain its position as a price/performance leader. The Model 705 has a starting price

HP holds the performance lead at the low end

(Specifications for major vendors' entry-level RISC workstations, based on minimum system configuration with a monochrome monitor and without a disk drive)

Company	Workstation	Price	RISC chip	Power rating (SPECmarks)	Assessment
HP	**HP/Apollo 9000**...... Model 705	$4,990	PA-RISC	34.0	Best price and performance, limited upgradeability
IBM	**RS/6000**...... PowerStation 220	$6,345	RS/6000	25.9	Entry-level IBM workstation, higher priced than competitors
Sun	**SparcStation** ....ELC	$4,995	Sparc	20.3	Relatively low-powered, limited upgradeability
DEC	**DECstation 5000**...... Model 20	$3,995	R3000	16.3	Lowest price, upgradeable,
	.... Model 25	$4,995	R3000	19.1	but low-powered

Source: Company reports

of $4,990, and the Model 710 carries a $9,490 price tag for a basic diskless system. The new computers, at least for the moment, allow HP to maintain its claim of having the most powerful workstations for the money. "Right now, I would say that HP is the strong player," says Dataquest's Segervall.

IRONICALLY, LIKE IBM, HP had been just another vendor written off as an also-ran in the workstation race. After HP acquired Apollo Computer in 1989 and found itself in a virtual tie for market share with DEC and Sun, the company slipped as it struggled to integrate the two companies. (That slip once prompted Sun CEO and president Scott McNealy to quip that Apollo, which marketed the first workstations in the early 1980s but later fell behind Sun, lost the workstation market lead *twice*.)

HP turned around that also-ran image last year when it introduced its 700 Series workstations based on its Precision Architecture-RISC microprocessors. HP was unable to keep up with demand for the new systems, due in part to a shortage of floating-point processor chips from Texas Instruments Inc. in Dallas, which constrained shipments of the line's more powerful systems until early this year. Nevertheless, UBS Securities Inc. analyst Marc Schulman in New York estimates that sales of the 700 Series are running at more than $1 billion a year and now outpace HP's aging Series 400 workstations based on Motorola's 680x0 chips. "The majority of our new customers are going for the 700 Series," Eichhorn acknowledges. Adds Harold Hickman, director of computer operations for Northrop's Information Services Center in Los Angeles, which recently purchased $5 million worth of Series 700 workstations and related equipment for its manufacturing operation, "we chose HP because it offered the price-performance superiority we needed."

Some observers do note that, while the Series 700 leads in terms of raw power, the workstations are more limited in configurability that competing systems. The Model 705, for example, has no expansion slots, and customers still have to ante up more than $11,000 for a color system.

HP's drive for the entry-level market is prompting its search for a suitable distribution channel for its low-end workstations, an obstacle all workstation suppliers face in trying to crack the commercial market. By their nature, workstations require more service and support than personal computers and so cannot be easily sold through mass merchandise channels. Last October, HP inaugurated a program to sell workstations and other gear through qualified dealers and signed MicroAge Computer Centers in Tempe, Ariz., and Intelligent Electronics in Exton, Pa., as the program's initial participants.

So what is happening at Sun? "One year ago, Sun Microsystems was the only vendor with a competitive system below $10,000," says Robert Herwick, managing director of technology research at Hambrecht & Quist investment banking firm, but it has fallen behind. The SparcStation ELC, currently the low end of Sun's line, has been on the market since July 1991 with a starting price of $4,995. At 20.3 SPECmarks, it is faster than DEC's Model 20 but falls short of competing HP and IBM workstations.

Sun's McNealy concedes that, in terms of providing monochrome workstations under $5,000, his company is no longer the leader, but he argues that Sun leads the market forcomputers under $10,000 with color and other capabilities. "We still feel pretty confident about the under-$10,000 market," he says.

Sun is known to be working on two new implementations of its Sparc RISC microprocessor—the high-end and low-end versions are code-named "Viking" and "Tsunami," respectively—to power its next wave of workstations. McNealy only hints at a "busy product calendar" for 1992 and declines to say more.

The dark horse in the commercial workstation market is Steve Job's Next Computer Inc., Redwood City, Calif., which is specifically marketing its 68040-based Turbo "professional workstations" for commercial use. Turbo prices start at $6,995 and the company recorded sales of $127.5 million in 1991. Customers include securities trading firms Lehman Brothers and UBS Securities, and the Los Angeles County Sheriff's Department. ☐

Multimedia mania: Time for a reality check?

The marriage of PC, VCR, and TV will spawn a multibillion-dollar consumer-electronics market in a few years. Maybe

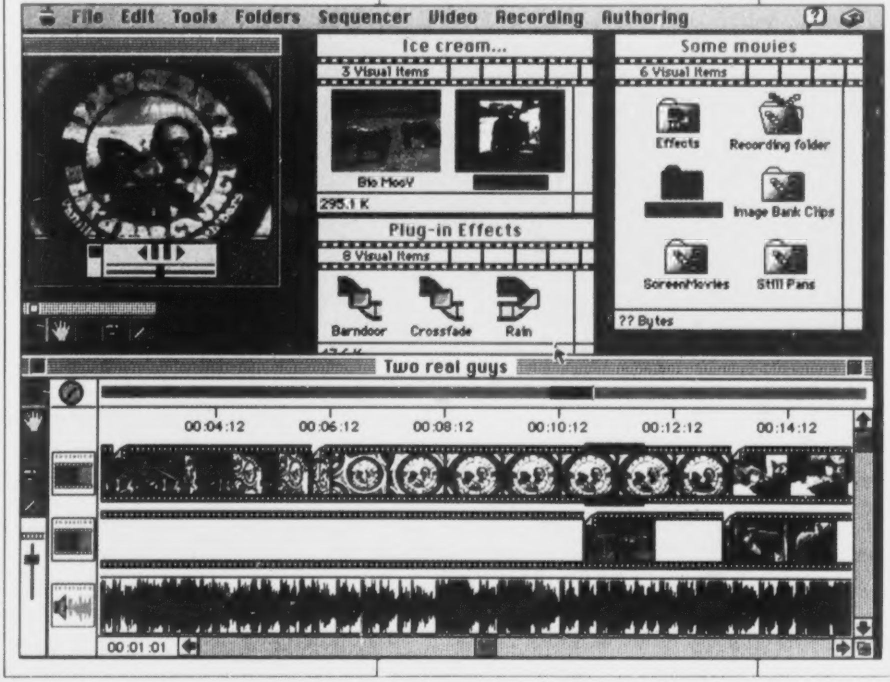
By Connie Winkler

After five-plus years of hype, and sometimes faked demonstrations on the alleged wonders of multimedia, many knowledgeable users and even those in the industry remain confused. Until several major vendors finally unveiled their multimedia products late last year, the most frequently asked question about multimedia was, "What is it, anyway?"

The spate of announcements last October and earlier this year, though, and the arrival of at least some systems on the store shelves, have cleared the air a bit. Now it's possible to understand what the manufacturers are talking about in terms of consumer versions of multimedia products.

At its simplest level, multimedia is the combination of several electronics technologies under one hood. One of the most popular configurations includes a high-performance PC with a CD-ROM player, a sound board, and hi-fi speakers. Another variation adds high-quality, sophisticated video playback. Applications developers combine these elements into games, education, and entertainment software. Multimedia disks for children have become the electronic equivalent of old-fashioned pop-up books: "Gramma and Me" from Broderbund Software Inc. in Novato, Calif., includes birds that fly and screech and a talking grandmother, and the child uses the mouse to double click on the bird or other story elements. Users can search through text, graphics, video, and sound clips as if their PC was linked to a video cassette recorder and a color television set.

Apple Macintosh zealots, and the rare Next computer user, pooh-pooh


File
Edit
Tools
Folders
Sequencer
Video
Recording
Authoring
Ice cream...
3 Visual Items
Blo MooV
295.1 K
Some movies
6 Visual Items
Effects
Recording folder
Image Bank Clips
ScreenMovies
Still Pans
?? Bytes
Plug-in Effects
8 Visual Items
Barndoor
Crossfade
Rain
Two real guys
00:04:12
00:06:12
00:08:12
00:10:12
00:12:12
00:14:12
00:01:01

A Macintosh computer running the VideoShop software from Digital Video Applications Corp. in Cambridge, Mass., created a multimedia presentation for visitors to Ben & Jerry's ice-cream factory. Company videos, video clips from The Image Bank, and sound effects were edited into an interactive system for a lobby kiosk. The icons in the upper right section of the screen represent special effects, image clips, and other elements. VideoShop enables users to edit videos and the sound track on a frame-by-frame basis, as seen at the bottom of the screen

Screen images ©1992 Ben & Jerry's Homemade Inc.

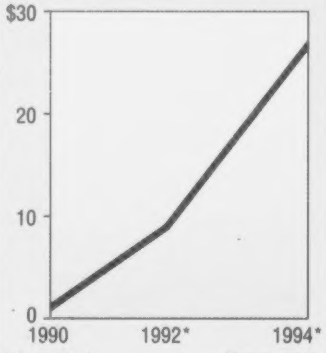
the sudden hoopla over text, graphics, and sound coming from desktop computers, saying these capabilities have been available to them for years. For the rest of the world, however, the point is that multimedia systems handle text, audio, and video in a package that costs less than $3,500.

MANY INDUSTRY executives view entertainment as the right direction for their company, especially if they make personal computers, although they initially targeted narrow markets such as industrial training. "Multimedia will unleash extraordinary potential for consumers," notes IBM president Jack Kuehler. "It will become a revolution in the computer-to-person interface." Executives such as John Sculley, the chairman of Apple Computer Inc. in Cupertino, Calif., go even further. He predicts that the multimedia revolution is an opportunity for U.S. companies to regain domination of the consumer electronics industry from Japanese vendors.

Maybe. But it probably won't happen right away. The dearth of software titles and the price are major obstacles to a lush consumer market. As Sony, Matsushita, JVC, and other Japanese companies have learned, consumer electronics sales are driven by software, and the demand for multimedia depends on what can appear on the screen. "Applications are too narrow—they don't appeal to a broad enough group of people, and most consumers aren't prepared for higher levels of interactivity," notes market researcher Michael Mascioni, who follows interactive multimedia for the market research firm Alexander & Associates in New York City. He suggests that couch potatoes don't know what to do with the capabilities of multimedia systems. Indeed, he's only half joking when he says that interactive multimedia may not take off until the Nintendo-MTV generation gets more purchasing power—and prices drop significantly.

Will multimedia be a big hit by 1994?

U.S. shipments ($ billions)



* Estimated Source: Inteco

Currently, there are only about 100 true multimedia titles available in various formats among 5,000 database CD-ROMs. Not including internally developed commercial applications, sales of CD-ROM based multimedia software will hit about $300 million this year, predicts Larry Shiller, president of the Bureau of Electronic Publishing Inc., a Parsippany, N.J., distributor of CD-ROMs. Industry officials predict that the number of titles will double by year's end. "About 25% of all CD-ROM disks sold last year were multimedia, but 75% of CD-ROM sales will be multimedia this year due to the surge of new titles," notes Shiller.

One of the hottest offerings in 1992 will be the multimedia version of *Time* magazine, from Compact Publishing Inc., in Washington, D.C., according to Shiller. The disk includes video from CNN, Time articles and pictures from 1923 to 1991, the Central Intelligence Agency's World Factbook, and other U.S. government data manuals. Robert Ellis, Compact's publisher, predicts retail sales of 5,000 to 10,000 units at $149 each through electronics stores like Circuit City.

The more conservative industry officials and market forecasters acknowledge that multimedia won't be a major consumer product and market until mid-decade. "I really believe that in a couple of years, trying to buy a PC without multimedia will be like trying to buy a car in Texas without air-conditioning," exclaims Ed Juge, the head of marketing for Fort Worth, Tex.-based Tandy Corp.

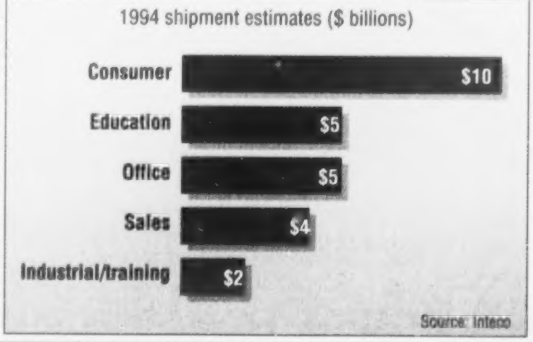
A $10 billion consumer hardware market by 1994 is forecast by Inteco Corp., a Norwalk, Conn., market research firm, along with a $5.5 billion software market that includes non-entertainment PC software such as spreadsheets and word processors with multimedia features. Alexander & Associates guesses that interactive entertainment hardware and software may be a $10-billion-per-year industry by the mid-1990s, or bigger than the projected market for HDTV. The multimedia boom is based on a low-cost—$500 or so—CD-ROM drive add-on to PCs capable of handling full-motion video and hi-fidelity audio and the availability of thousands of applications.

Forecasts of a three- to five-year evolution of multimedia into a consumer product are based on the pattern established for other advanced home electronics such as the VCR and the microwave oven. Interactive entertainment "as a consumer market is not springing up fully organized and rationalized," noted a recent Alexander & Associates report on Interactive CDs. "It will go through the same kinds of struggles that the VCR market and personal computer markets have had to suffer."

Mascioni notes that the comparison between multimedia and VCRs has a flaw—the movies that spurred demand for VCRs were an old wine waiting to be repackaged in a new bottle. Interactive media is barely at the grape-stomping stage—compelling software isn't sitting around waiting for someone to repackage it for a box full of microchips.

WHILE WAITING for the consumer titles and lower-priced hardware, vendors are focusing on a thriving market for commercial applications, each representing a relatively narrow niche. Advertising agencies mock up television campaigns on Macintosh computers outfitted with multimedia hardware and software. Stand-alone PCs equipped with a CD-ROM player, speakers, and a color screen are used as information kiosks for customers at auto dealerships, clothing stores, and other retail venues. Among the hottest business applications touted by IBM, Intel, and other vendors is a video version of electronic mail—office workers would create video messages at the desktop and distribute them via local area network.

Consumer products to dominate multimedia hardware market



Source: Inteco

Commercial applications and the education market are driving a $6 billion hardware market for multimedia this year, according to Inteco. The 1992 consumer hardware market will ring up almost $3 billion in sales if the economy shows signs of improvement by mid-year and the surge of promised titles actually reaches stores.

Schools and libraries represent the largest commercial sector, at $2 billion this year. Electronic versions of encyclopedias are the top sales category of multimedia disks, according to Shiller. Encyclopedias and history texts are gobbled up by libraries as a way of attracting the Nintendo generation to reading.

Sorely missing from most PC multimedia specs is the capability to handily and cheaply present a high-quality and full-screen video on a PC. One minute of multimedia programming with a true-color, full-motion video occupies more space than is available on a 660-megabyte CD-ROM disk, so the consumer market depends on data compression. Although every day there's another option, no solution available today provides the necessary compression/decompression at the $500 price target for a consumer market to develop; the Digital Video Interactive (DVI) boards from Intel Corp. in Santa Clara, Calif., costs around $2,000. More than a dozen established semiconductor vendors, start-up software companies, and fabless chip makers are working on video compression, though, and prices are predicted to erode rapidly this year (see "Chip makers race to solve video puzzle," page 100).

ANOTHER PREREQUISITE for a multimedia system, and a key enabling technology, is a CD-ROM player. The lack of compelling software has limited consumer penetration for the drives, although sales are growing rapidly to business users. Shipments should triple by 1995, to 1.25 million units, from the 400,000 units achieved in 1990, according to Freeman Associates, a data storage marketing consultant. However, "1.25 million CD-ROM drive units will be only 10% of the, say, 10 million PCs shipped," notes Bob Abraham, vice president of the Santa Barbara, Calif., research firm, "but 10% penetration will be more than a moral victory." Currently, low-end CD-ROM players are available from mail-order houses and discount retailers for less than $500.

Not surprisingly, another major obstacle to a broad-based multimedia market is not a lack of technology, but a surfeit of it. Anyone who has tried to get data from one graphics, text, or video application into another—even with software supposedly designed for the same platform—probably would prefer a tooth extraction without anesthetic to doing it again. And forget about moving graphics across platforms. "Multimedia is not significantly different from any other emerging area of technology that has tremendous potential," says Larry Lytle, until recently executive director of the Interactive Multimedia Association (IMA) in Washington, D.C. "There are going to be standards issues." IMA has taken the lead to resolve the incompatibilities by drawing together more than 240 companies into a Compatibility Project to hew standards. "Instead of half a dozen technologies or standards, we may have two or three, as with Unix," Lytle predicts.

Typical of any nascent computer market, other standards are evolving. In the late 1980s, Microsoft Corp. in Redmond, Wash., recognized the need for standards and began a campaign to rally other supporters. By 1991, AT&T, NEC, Philips, Tandy, Zenith, and more than a dozen other manufacturers and developers eager for technical standards jumped onto Microsoft's bandwagon touting its Windows environment for DOS with multimedia extensions and data interchange standards as a common interface; notably absent from the group were IBM and Apple. Shelling out $250,000 each (primarily for big bucks advertising and public relations) these manufacturers set up the Multimedia Personal Computer (MPC) Marketing Council attached to the Software Publishers Association of Washington, D.C. Although originally the standard settled for as little as an Intel 80286-based system, by December 1991, Microsoft had acknowledged the need for more power, and the standard is now a 80386SX-based system.

Of course, not everyone agrees with the MPC Council's approach. "I can't imagine doing multimedia if you exclude IBM and Apple," snipes Lytle, the former IMA officer. Furthermore, the 80286 spec delayed multimedia development by at least six months while developers wrestled with it, contends Graham Taylor, executive vice president of Inteco. "Microsoft had egg on its face. However, the other standards are a big help to the Windows community. MPC will be a major force to be reckoned with."

HERE'S A LINE-UP OF the multimedia game's players and their strategies:

- **Philips** "The era in which individuals and families can interact with their television sets for entertainment or to learn about virtually any subject arrived today," boasted Jan Timmer, president and chairman of Philips Electronics, N.V. in the Netherlands, at the splashy New York announcement last October for CD-Interactive, its VCR-like box cum microprocessor which plays CD-ROMs and attaches to a TV. Industry observers estimate that Philips has spent hundreds of millions of dollars introducing CD-I.

The early reaction to Philips's marketing blitz is indicative of the marketing challenge facing vendors. Although CD-I was introduced at $1,000 at some major audio and computer dealers, by Christmas 1991 the suggested retail price was cut to $799 in the face of modest demand, and it was available in New York City for $750. To boost its utility, Philips is working on full-motion video on CD-I.

"Buying a PC without multimedia will be like trying to buy a car in Texas without air-conditioning," predicts Ed Juge, Tandy's director of market planning

- **Commodore** In February 1991, Commodore took the initiative in introducing CDTV, an interactive CD-ROM player, similar to CD-I. However, by late 1991, Commodore officials said that the company had shipped only 30,000 units worldwide at a retail price of $799, also discounted. Industry observers note that CDTV has been more successful in Europe than in the U.S. and warn that the company doesn't have the financial resources necessary to market the product.
- **Apple** Last year Apple introduced QuickTime, a group of extensions to its Macintosh operating system that allows developers to integrate sound, video, and animation within applications. In addition, the company also unveiled video compression and a CD-ROM for multimedia applications development.

Dozens of software and hardware vendors have announced support of QuickTime, including Aldus, RasterOps, WordPerfect, ABC NewsInteractive, and Radius. A consumer-oriented Macintosh bundle will ship to retail stores later this year, Sculley announced at the Consumer Electronics Show last month. QuickTime will be contributed to Kaleida, the joint IBM-Apple effort to develop multimedia standards and software.

- **IBM** IBM's Atlanta Multimedia Systems Group in October announced a multimedia PC and a big thrust into the market for sales tools. The PS/2 Ultimedia Model for $5,995 has advanced Extended Graphics Array technology. Users can add full motion video through IBM's adaption of Intel's DVI technology, called IBM PS/2 ActionMedia II adapter board, for $1,995. Or they can watch television feeds on the PS/2 screen via the $495 PS/2 TV screen.

IBM also introduced two mega-multi-media learn-

The outlook for the players and their strategies

Quotes from market analysts

Vendor	Markets	Outlook
Apple	Consumer Education Developers	"Easiest to use... successful in rallying allies"
Commodore	Consumer Developers	"Will it have enough money?"
IBM	Training Sales	"A leader... targeting Apple's strengths"
Kaleida (IBM & Apple)	Consumer Software	"Will take a big slice of these business"
Microsoft	Consumer Developers' software	"Major force to be reckoned with"
Philips	Consumer	"Good try... but will it keep spending?"
Tandy	Consumer Small business education	"Ideally placed... strongly positioned"
Japanese companies	Consumer	"Cautious"

Source: ELECTRONIC BUSINESS

Chip makers race to solve video puzzle

REAL-TIME full-motion video is the Achilles heel of multimedia. Television quality video requires displaying 30 frames per second on the screen, and each frame requires 1 megabyte of data. Video compression and decompression technology must squeeze hundreds of gigabytes of data required for an hour-long video to be stored on a 660-Mbyte CD-ROM. The challenge, and the potential for consumer sales, has attracted so many chip makers including the major semiconductor makers, established vendors, and start-ups that a bloodbath is predicted. "Competition and the erosion of pricing among video compression chip vendors will closely resemble the disk drive business in the 1980s," warns Nick Arnett, chief analyst of Multimedia Computing and Presentation Corp.in Santa Clara, Calif.

RCA's David Sarnoff Laboratories in Princeton, N.J., pioneered video compression in the late 1980s. Intel Corp. in Santa Clara bought RCA's Digital Video Interface (DVI) technology in 1988 from its parent, General Electric. In February 1990, Intel introduced a two-board DVI system for PCs (priced at about $4,500) that compressed video at a 160:1 ratio. The current version of the key video chip is essentially a CMOS processor with around 300,000 transistors, running at a 25-megahertz clock rate and capable of around 25 MIPS. "DVI is the only technology that does full-motion, full-screen video," notes Arnett. The latest two-chip set sells for $85 in OEM quantities, but an Intel official predicts a $50 price tag later this year.

Among Intel's video compression competitors is Integrated Information Technology Inc. of Santa Clara. IIT's video processor chip boasts compression ratios of up to 1,000:1. Boards based on its 33-MHz chip, which is made by National Semiconductor Corp. in Santa Clara, are available for Macintosh computers as well as for PCs. IIT's chips are the heart of AT&T's recently announced Videophone 2500. Prices for a two-chip set begin at $85 in OEM quantities. Additional competitors include Motorola, AT&T Microelectronics, and the major Japanese semiconductor makers, and each has announced a video compression chip project.

Other video compression players include a start-up, Fluent Machines Inc. in Framingham, Mass., funded in part by Cirrus Logic Inc. in Fremont, Calif. Its CMOS chips will be fabricated by Cirrus's Pixel Semiconductor subsidiary in Plano, Tex., by mid-year. Fluent predicts that the cost of compression boards will drop by 75% by year's end. Other industry officials consider anything more than a 30% decline unlikely.

—Larry Marion

ing systems, "Columbus: Encounter, Discovery, and Beyond" and "Illuminated Books and Manuscripts," which IBM contends will capture the MTV generation. Each product occupies multiple CD-ROMS and laser discs, costs more than $2,000, and requires about $10,000 of hardware.

- **DEC** In contrast to IBM, DEC isn't messing with stand-alone multimedia. In October, it began showing a technically sophisticated networked multimedia approach that aims beyond just digitized input, to include telephone, voice, facsimile, color graphics, video, and traditional text prepared for large organizations. For example, DEC envisions that retailers might tie together 12 video kiosks throughout their store to a file server.
- **Tandy** Tandy is visibly supporting the MPC standard while developing and pushing its own systems to the home market. But price levels of $3,495 and up are a bit rich for home users. "We really expect that, through 1992, the majority of purchasers will be either people in the educational community or business people who need delivery vehicles for multimedia titles," notes Tandy's Ed Juge. Tandy predicts a three- to five-year ramp-up for the consumer multimedia PC market if developers produce hot titles.
- **Japanese computer vendors** Fujitsu, a member of the MPC Council, continues to enhance its FM Towns CD-ROM system in Japan, but at a November developers' conference, its U.S. team said it will be at least a year before the black Mac-like system is available here. In Japan, more than 250,000 units of a non-Windows version have been sold, and the company claims that a Windows version of FM Towns will be available in March.

Although a partner with Philips for CD-I, Sony also introduced its own CD-ROM product, DiscMan, a $549 portable CD-ROM player that allows the user to have access to a mini-keyboard and screen in order to run a foreign language dictionary while travelling in a foreign country.

While rumors about an impending multimedia product alliance between Sony and Apple are running rife throughout the industry, Sony officials are reportedly scaling back their short-term expectations about the multimedia market. Overall, "the Japanese are much more cautious," observes market researcher Mascioni, in comparison to their all-out war over VCRs in the late 1970s and early 1980s.

- **Video-game makers** A big unknown are the plans of Sega and powerhouse Japanese game maker Nintendo. A CD-ROM player from Nintendo is due in January, following Sega's CD-ROM add-on due in 1992 with a $349 price. ☐

Pick-and-place vendors battered by Germany's spending cuts

U.S. suppliers must offer top-notch service to grab the few opportunities that remain in a cost-conscious market

By Barbara N. Berkman

Described just a year ago as Europe's economic powerhouse, Germany today seems more like a sputtering, wheezing engine. Annual economic growth rates have slid from about 3% last year to 1.5% or so, according to the Deutsche Bank, while short-term interest rates climbed from 8.75% to 9.3%. One result: plunging capital investment, which has defied U.S. equipment makers' best efforts to sell into Europe's biggest electronics market.

Germany has never been an easy market for U.S. suppliers, but the current recession—the first to touch the traditionally robust German electronics industry, according to a source at VDMA, the Munich-based trade group for Germany's equipment manufacturers—adds yet another twist to the somersaults U.S. producers already must perform for demanding German buyers. For equipment vendors, that means meeting exacting specifications, providing equipment that is fully compatible with existing production lines and computer systems, and offering impeccable customer service.

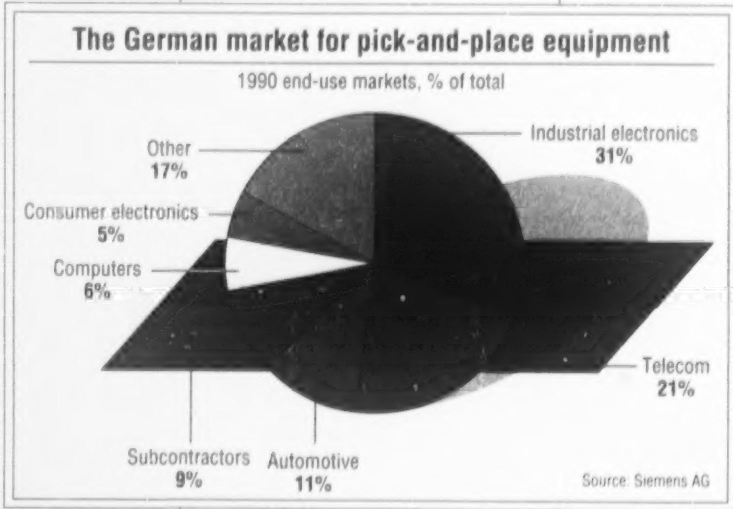
You needn't look further than the German pick-and-place market, the largest in Europe, for examples. German electronics producers bought some 450 units last year, that were valued at about $134 million, according to estimates by Siemens AG. Siemens predicts that volume sales will rise 10% this year to reach a market value of $236 million.

Among 70-odd vendors of pick-and-place machines, Siemens dominates the German market with a 55% share by units placed and a 70% share by value. The company's high-end machines typically run between $500,000 and $625,000. U.S. vendors include Dynapert in Beverly, Mass., Quad Systems Corp. in Horsham, Pa., and Universal Instruments Corp. in Crystal Lake, Ill. Other major players include Japan's Panasonic, which has about a 20% market share, Fuji, and Yamaha.

Most of those companies will find the German market especially tough sledding this year for at least three reasons:

- Many German customers will opt to use their machines 24 hours a day rather than buying more equipment, predicts Harald Bollen, Munich-based sales director of Siemens's automation group;
- The market is reaching the saturation point (especially among midsize companies) just as more aggressive players—including Panasonic—are charging onto the field. As a result, prices for entry-level machines could erode this year by as much as 20% from last year's range of $125,000 to $150,000;
- German buyers will exercise their well-known penchant for imposing strict demands for flexible component feeder capacity that allows quick changeover from one circuit board type to another.

Dynapert is moving along several fronts to boost its sagging German sales by 10%. The company underwent a restructuring move in 1991, added a vice president for


The German market for pick-and-place equipment

1990 end-use markets, % of total

Source: Siemens AG

Europe, and laid off 10% of its European work force when it shifted to a just-in-time delivery system. Dynapert also launched a service and spare-parts center in Frankfurt and launched a Europe-wide marketing, advertising, and direct-mail campaign touting its Intelliplace SMT range. "You must be strong in Germany to be strong in Europe," says Norman Hodson, market development manager in Colchester, England. Hodson predicts that the company's best-sellers in Germany will be a high-speed chip shooter, launched last November in Europe, and the I-318, newly revamped for European safety standards.

Quad Systems introduced a high-accuracy, medium-speed machine in 1991, called the 3C. Before that, "our products were targeted to the home market, not to Europe," admits marketing manager Kenneth W. Horton. In 1991 Quad enlisted Macrotron (UK) Ltd. in Swindon, England, as its European rep to peddle the compact machine, priced at $187,000 to $300,000.

PART OF QUAD'S strategy for servicing its German customers is to train Macrotron people in the United States. Horton concedes, however, that "there still will be a perception we'll be unable to support the machines." At best, he hopes Macrotron will sell 10 units in 1992 in Europe. Macrotron is targeting smaller German companies that aren't already SMT customers, says Kevin Barry, Macrotron's European sales and marketing manager.

Universal Instruments refers to its pick-and-place business in eastern Germany as "a little plus" in an otherwise flat German market; company sources claim more than 50% of the business in the region, with 1991 sales of about $9 million. "They can't pay cash, so we work out financing and leasing programs," says Dierk Muller, Universal's vice president of European operations in Bad Vilbel, Germany.

By running their machines during three shifts, German pick-and-place customers put extra pressure on vendors to provide fast local customer service. "Our philosophy is zero-hour—not 24-hour—service," says Holger Scheler, the manager of production engineering at Hagenuk in Kiel, Germany, a cordless phone maker and Siemens customer.

That's where many vendors typically run into trouble. Some German customers still nurse the perception that new non-German machines are incompatible with the vendor's older lines—one reason why customers such as Scheler favor Siemens. "Siemens is prepared to modify its existing lines to meet requirements of future technologies," he says. With Universal, he complains, "every year is a circus" because of incompatibility between new and existing equipment.

Not so, retorts Universal's Muller. He concedes that in the past the company offered new machines that weren't fully compatible with other Universal products, but it fixed the problem. Still, the image lingers. Its equipment is "not too impressive" and is fine "for through-hole, but not SMT," says pick-and-place customer Christian Scherf, business engineer with Robert Bosch GmbH. Universal pegs its share of the German market for through-hole machines at 60%.

The pressure clearly will be on suppliers to boost their customer-service presence this year, especially given the aggressiveness of Japanese companies. Panasonic opened a support center in Hamburg, hired 15 new German employees, and expects to hire 10 more in 1992. The company "wants to attack the competitors' customers," says Franz-Josef Hueske, Hamburg-based sales manager for Panasonic Factory Automation Deutschland. Business stolen from Siemens and other vendors accounted for about 10% of Panasonic's 1991 sales in Germany, and most of it was due to higher levels of customer service. Although Panasonic is well-established in high-end equipment, the company is now focusing on midrange machines priced from $187,000 to $375,000. "That is where we will meet Siemens," says Hueske.

German customers use equipment nonstop rather than buying new, says Siemens's Harald Bollen

For its part, Siemens is slashing production costs by moving functionality from hardware to software, sourcing more components from the Far East and the U.S., focusing on high-end special applications, and increasing sales to existing customers through upgrades.

Other European suppliers are having to settle for what amounts to table scraps. Technimount, a division of Fabrilec in Sint-Niklaas, Belgium, does a $5 million business in pick-and-place in Europe but has sold only three machines in Germany. President Hugo Michiels hopes to woo German customers with better service—installing modem connections from customers' machines to fault-analyzing computers in Brussels, for example.

Europlacer in Velizy, France, introduced a high-end $295,000 machine last June and projects German sales at 20 units in 1992, but so far it has sold only three. Those sales could give the company the much-needed endorsement to generate additional business. "Now we hope for a snowball effect," says product manager Christian Brozinski of Europlacer's German agent Peter Jordan GmbH in Offenbach, Germany.

That, of course, is what almost everyone is hoping for. "It's hard to sell the first system," says Macrotron's Barry, a lament that no doubt will be heard often this year from many U.S. equipment makers. □

Why Sematech is more than just a rich man's club
PAGE 57

Zeos tops our list of fastest-growing companies
PAGE 83

FPGA profits attract a crowd of hungry vendors
PAGE 113

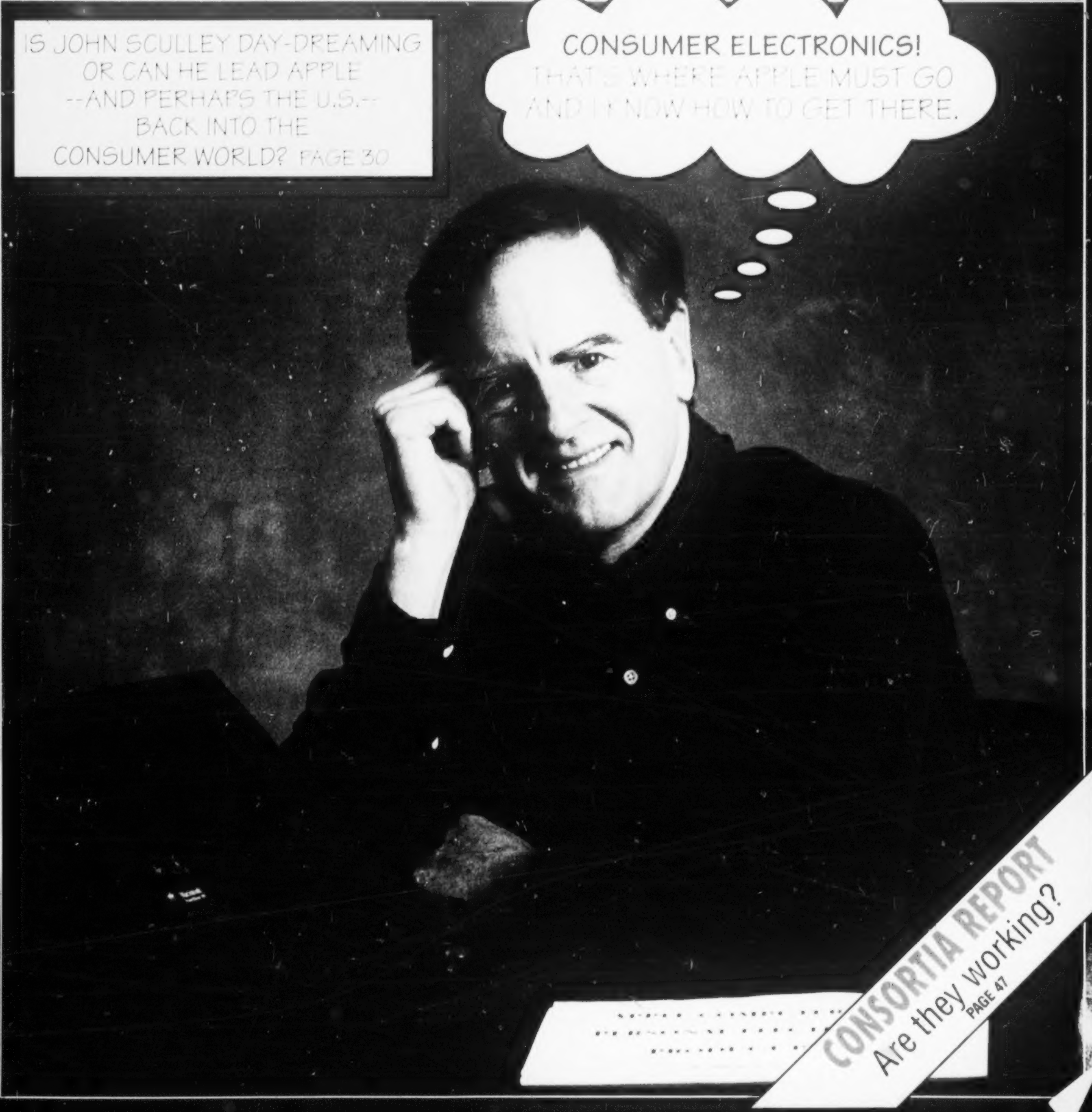
A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPA WORLDWI

MAY 18, 1992

IS JOHN SCULLEY DAY-DREAMING
OR CAN HE LEAD APPLE
--AND PERHAPS THE U.S.--
BACK INTO THE
CONSUMER WORLD? PAGE 30


CONSUMER ELECTRONICS! THAT'S WHERE APPLE MUST GO AND I KNOW HOW TO GET THERE.

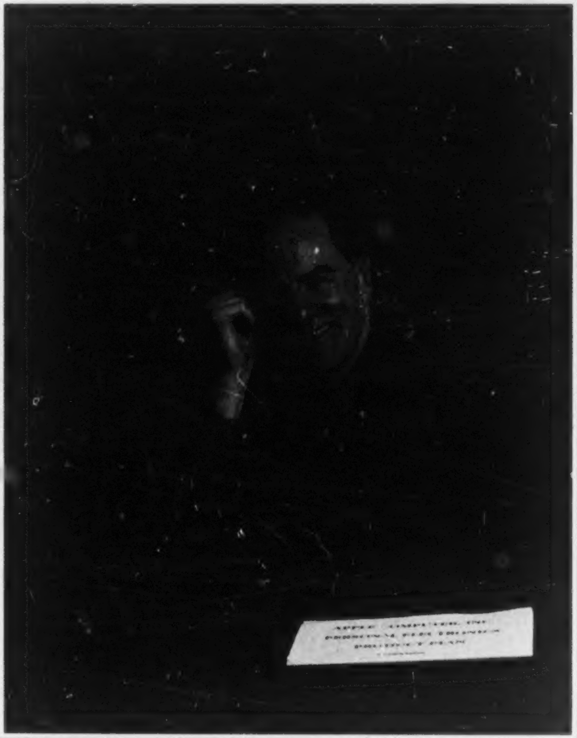
CONSORTIA REPORT
Are they working?
PAGE 47

Electronic Business

VOLUME 18, NUMBER 8

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

MAY 18, 1992



PAGE 30 John Sculley, Apple Computer's chairman and chief executive

COVER STORY

BUSINESS STRATEGY

30 Consumer electronics! That's where Apple must go and I know how to get there

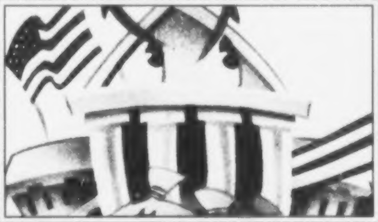
Is John Sculley day-dreaming, or can he lead Apple back into the consumer world? Unproven product appeal, unfamiliar marketing channels, and the need to depend on foreign partners all mean success is far from assured. Nevertheless, Sculley is willing to take a chance

Cover photo by Rick Smolan

UPFRONT

Business Trends

11 The IRS wants to extend its reach to U.S. foreign subsidiaries; Top 10 technologies on IS managers' shopping lists; Is there a risk of DRAM déjà vu all over again?; Who's world-class and what they're doing to stay there; Semi materials becoming one big niche



PAGE 11 The IRS tries to reach foreign subsidiaries

Companies to Watch

23 Sunrise Test System creates test programs for integrated circuits; Mini-Stor Peripherals offers smaller drives; Stratos pushes product development services

PAGE 23 From left, Charles Cump, president; Jean-Pierre Braun, VP of engineering and marketing; and Tom Niermann, VP of R&D of Sunrise Test Systems

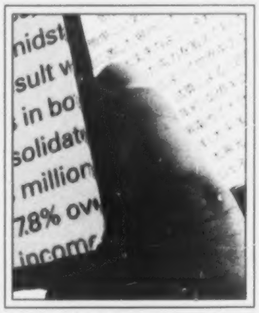
Business Barometer

27 Distribution
The recovery is here at last, say distributors

27 Semiconductors
Chip sales rise briskly, but more layoffs are likely

28 Leading Indicator
Indicator levels off in March

PAGE 67 MCC chief executive Craig Fields



PAGE 103 How to uncover what's really inside Japanese annual reports

PAGE 113 Too many vendors could sink profits in FPGAs

FEATURES

PRODUCT DEVELOPMENT & MANUFACTURING

47 **Consortia: Are they getting any better?**
Yes. It's been a painful process, but they are finally producing results

57 **Bill Spencer struggles to reform Sematech**
That's a challenge. The chip industry is healthier because of Sematech, but its benefits aren't spread evenly—or perhaps fairly

67 **MCC digs out of the "celestial sandbox of computer science"**
CEO Craig Fields balances blue-sky research and feet-on-the-ground payoffs

69 **Start-up no more, Jessi gets down to business**
Europe's chip consortium has met its early goals but faces internal squabbling and radical funding cuts

75 **Washington brightens the outlook for manufacturing consortia**
The Senate removes another obstacle to industry teamwork

79 **What consortia can and should do**
Teaming up pays if everyone observes a few simple rules

FINANCE & ECONOMICS

83 **Is this any way to sell computers? Zeos thinks so**
Hawking nimble service and reliable machines by mail has made it 1991's fastest-growing electronics company

91 **A listing of the 100 fastest-growing electronics companies**
Computers and software dominate the top half of our 1991 list

97 **Facts behind the figures**
Recession felled the old guard, while IPOs helped newcomers

INTERNATIONAL

103 **What's really inside Japanese annual reports: Part II**
New data reveals the lean operating style of leading Japanese electronics companies

MARKETS

113 **FPGA market booms, but too many vendors could sink profits**
Patent fights, price pressures, and third-party tools will cull winners from losers

125 **Notebook PC makers struggle to survive at "sub-survival" prices**
Vendors seek new product designs that won't break the R&D bank

DEPARTMENTS

Inside Business

7 Keeping score on industry teamwork

My View *By Frank Burge, publisher*

133 The virtual enterprise. And virtual profits

Company Index

135 Companies covered in this issue

Advertiser Index

137 Advertisers covered in this issue

Viewpoint *By John Russell, editor*

140 If I were President, here's what I'd do

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), John Parker
Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

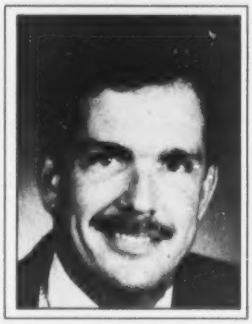
CIRCULATION

Circulation Manager: Ken Evans
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

Keeping score on industry teamwork



Associate editor David Webb

Born of hard times and patriotic fervor, electronics industry consortia were supposed to be America's answer to the nationally sponsored R&D juggernauts rolling in from Europe and the Pacific Rim. How well have Sematech, Semiconductor Research Corp., and Microelectronics and Computer Corp. fulfilled our expectations?

Not well, if you consider enlistment of wholesale participation: Only 60% of the nation's electronics companies own shares in the three organizations, and only 36% of the CEOs surveyed in our exclusive ELECTRONIC BUSINESS/Ernst & Young survey plan to increase consortium participation.

There are signs of progress, however. In our cover story, senior editor Peter Burrows reports that, beyond merely surviving, Sematech, SRC, and MCC have defined more practical roles and have begun putting solid business principles into practice. The numbers of researchers on silicon-based development projects have grown, and plans for new fab sites have given way to a focus on precompetitive generic research.

There's even progress in Washington, although the current administration still has trouble dealing with "the competitiveness thing." Congress is moving toward easing antitrust restrictions on joint R&D programs. Contributing editor Willie Schatz explains how the National Cooperative Manufacturing Act will help companies who want to pool their research assets and describes how to seek government approval under the act's provisions.

For comparative purposes, London-based editor Barbara Berkman provides an in-depth look at the successes and weaknesses of Jessi, Sematech's European counterpart.

There may be hope for a U.S. resurgence in processor technology, but what about consumer electronics? With the U.S. holding only 13% of worldwide production, the market might look like a lost cause. Then again, maybe not. Associate editor David Webb in San Jose reports that the folks who brought you the laser printer and the graphical user interface are planning a comeback. In the future envisioned by Apple Computer's John Sculley and Hewlett-Packard's John Young, U.S.-made "information appliances"—handheld computers and VCR-size transceivers—will provide consumers with a combination of interactive television, on-line information services, and sophisticated personal computing.

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.**
ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer.
Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

BPA ABP

TAX POLICY

The IRS wants to extend its reach to U.S. foreign subsidiaries

BY NEXT YEAR, it could be tougher for U.S. companies to use foreign subsidiaries to achieve tax breaks. The IRS wants to close loopholes in the tax code that allow U.S. parent companies to report lower income and thus pay less taxes.

Here's how the practice works: A U.S. chip maker could license a design to its Taiwan subsidiary. The subsidiary might build the chip at a cost of $5 each, then "sell" it back to the parent for $50 each. If the parent sells the chip for $60, it pays U.S. taxes only on the $10 profit. The $45 profit of the subsidiary is subject to taxation by Taiwan only, often at a much lower rate.

U.S. companies have sidestepped taxes by recording these high buyback costs from subsidiaries, while the subsidiaries record higher profits out of reach of the IRS. The specific loophole results from the vagueness of U.S. tax regulations regarding intangible costs, such as chip design.

The IRS wants to crack down on companies it says are cheating—ostensibly by reporting minimum profits on goods "bought back" from offshore subsidiaries with a high percentage cost of intangibles. Because U.S. electronics companies often ship out parts for offshore assembly, the industry is a prime target of increased IRS scrutiny.

"There is a great deal of uncertainty about how one should structure relations with their foreign subsidiaries," says David Swenson, partner at Baker & McKenzie, a Washington law firm working with the IRS to reinterpret the regulations. Confirms Ray Rossi, manager of external tax affairs at Intel Corp., "The regs don't lend themselves to reality."

The generally accepted standard for determining the fair costs and profits between a mother company and its offshore subsidiary is the "arm's length" rule. It states that costs are determined as if subsidiaries were independent suppliers no closer than "arm's length" to avoid blatant profit record gerrymandering. The Treasury Department will reportedly seek a stricter interpretation of the arm's length rule.

"One significant thing about the new regulations is that the IRS hasn't been particularly successful in litigating these issues. The view is that the [proposed interpretations] of the regs will tilt the playing field in favor of the IRS," says Tom Gibson of Price Waterhouse.

Companies doing business in Europe, for example, would be effectively double taxed—once by the host country, and once by the U.S.

"There's no question that these [proposals] add to the complexity of complying with tax laws. It can also put strain on treaty relationships with other countries," Gibson says.

Curiously, the same tax issue has led to charges that foreign firms are exploiting the laws by charging their U.S. subsidiaries inflated prices for goods made in Japan and elsewhere, so the subsidiary is taxed only on the small mark-up to the end-user in the U.S. Most of the profit is kept overseas where tax rates are more favorable. Rep. J. J. Pickle, (D-Tex.), says foreign companies are cheating the U.S. Treasury out of $30 billion a year using such loopholes.

The American Electronics Association has not yet determined the full impact of the proposed changes but created a committee in April to examine the issue, says Ed Hatcher, director of tax policy at the AEA in Washington, D.C. At first glance, though, he's not optimistic. "The proposed regs . . . are very close to being a disaster," he says.

—David Webb in San Jose

TECHNOLOGY

Top 10 technologies on IS managers' shopping lists

TEN technology areas—as identified by more than 1,750 information systems (IS) managers in a recent spending survey—are booming, even as IS departments try to cut costs. If you're not already a vendor in these, take another look.

Most of the IS departments polled by Cahners Publishing's *Datamation* magazine and the Business Research Group (BRG) in Newton, Mass., are developing LANs, incorporating existing mainframes and minicomputers into the networks as servers. Only 18% reported mainframe-based applications development this year.

The shift to LANs is in response to the stringent cost-control measures adopted at most IS departments this year. The average budget increase is a paltry 4%, according to the IS managers responding to the survey questionnaire in January.

The 10 hottest technologies of 1992

(% of sites reporting implementation plan)

Local area networks	46
Client-server architecture	43
Graphic user interface and windowing software	37
Bar-code scanners and software	35
Relational data base management software	33
Desktop computers	33
Laptops	29
RISC workstations	27
Minicomputers	26
Fiber	23

Source: 1992 MIS Strategic Planning Study by Datamation/BRG

Other money-saving technologies being adopted by a significant number of companies include bar-code processing to improve the accuracy and timeliness of inventory management and retail sales and relational database management systems to improve management's ability to identify product and marketing trends (see table). One pleasant surprise for some vendors: strong demand for the embryonic handheld computers. More than 10% of the survey respondents indicated that they were developing applications based on the recently announced technology, though most of the products have yet to ship.

For more information about the market prospects of more than 40 hardware and software technologies included in the questionnaire, contact the BRG at (617) 630-3900.

—Larry Marion

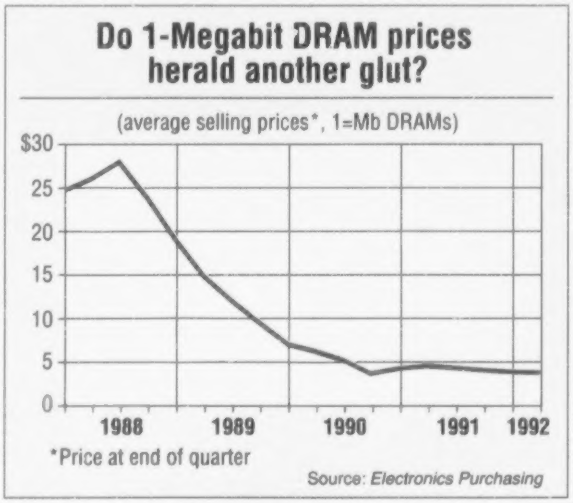
MARKETS

Is there a risk of DRAM déjà vu all over again?

SINCE LAST summer, average selling prices of dynamic RAMs have plummeted, raising concerns that the industry may be setting itself up for another DRAM recession.

"There is a huge amount of DRAM overcapacity at the moment, and that same situation drove the industry into its worst recession in the mid-'80s," says Gordon E. Moore, chairman of Intel Corp.

The price for 1-megabit DRAM chips fell from about $4.75 in July 1991 to about $4 this April, according to statistics from *Electronics Purchasing* magazine (a Cahners publication). Some sources claim the 1-Mbit chips can be bought today for as little as $3 to $3.50. Meanwhile, insiders say, 4-Mbit DRAM chips that sold for close to $20 last summer can now be had for just $11 or $12.



Do 1-Megabit DRAM prices herald another glut?

(average selling prices*, 1=Mb DRAMs)

*Price at end of quarter

Source: *Electronics Purchasing*

Despite these price drops, some in the industry question whether the cause is production overcapacity, which could trigger a recession. They argue the cheap DRAMs may have resulted from Far Eastern manufacturers "blowing off" bloated inventories. DRAM maker Micron Technologies apparently thinks the "blowing off" has gone to an extreme. In late April, Micron filed dumping charges against three Korean DRAM manufacturers.

Dumping questions aside, the changing economic scene makes it unlikely that the industry will see a repeat of the mid-1980s. DRAM production facilities then were built at a rate that far outpaced the market demand. Japanese manufacturers were enjoying zero cost of capital thanks to the rate of the yen's appreciation. Return on capital wasn't part of the business or capacity planning process.

Today, though, Japanese manufacturers are carrying very heavy debt loads and are facing the prospect of refinancing their paper at higher interest rates.

"Japanese companies have cut back substantially on their [production] capacity additions," says one source. These economic factors are likely to persist through the 1990s, he believes, so he doubts there will be a recurrence of the 1980s' DRAM debacle.

—Dwight B. Davis

COMPETITIVENESS

Who's world-class and what they're doing to stay there

ONLY ABOUT 20% of electronics manufacturing companies rate themselves as "world class" or approaching world-class status, according to a study recently released by Deloitte-Touche Manufacturing Consulting Services.

The study provides a strategic profile of 169 North American electronics companies and was based on responses from 872 executives. Nearly all of those companies claiming world-class status also reported they are still trying to improve. High on their hit lists: supplier and customer relationships, human resources, and technological leadership.

Pursuit of organizational excellence in the electronics industry is expanding into a broad-based initiative, says Ron Chapman, national director for the high-technology group at D&T. Whereas high product quality was once sufficient definition of world class, excellent customer service and other factors are now necessary to gain that distinction. The average rates of improvement in delivery time and internal quality were greater for world-class companies than for those who did not consider themselves world class.

"World-class companies are using programs like quality function deployment to bring the voice of the customer into their design process," Chapman says. QFD also allows manufacturers to plan for two or more product changeovers simultaneously, shortening time to market and increasing customer satisfaction.

Computer integrated manufacturing is another factor that separates the world-class players from their competitors. About 33% of the executives polled said they had no plans for CIM environments and 46% are planning CIM, but only 5% have implemented it in their manufacturing environments.

—Hugh Willett in San Jose

MARKETS

Semi materials market nears $10 billion

Worldwide consumption ($ millions)

	1991	1992	1993	1994
Wafer fab materials	$5,019	$5,342	$5,770	$6,341
Silicon wafers	2,090	2,215	2,414	2,700
Other substrates	264	279	314	352
Photo masks	1,120	1,202	1,250	1,320
Photoresists	248	263	284	305
Wet chemicals	444	468	506	546
Gases	603	640	700	780
Deposition materials	250	275	302	338
Packaging materials	$4,151	$4,344	$4,812	$5,215
Leadframes	1,239	1,313	1,431	1,603
Ceramic packages	951	1,037	1,308	1,410
Encapsulation resins	472	500	545	610
Bonding wire	334	354	385	431
Thick film pastes	205	195	190	190
Cerdip	197	193	189	185
Seal lids	234	222	220	220
Headers and cans	100	100	95	90
Other	419	430	449	476
Total	$9,170	$9,686	$10,582	$11,556

Y130=$1

Source: Electronic Materials Report

THESE LITTLE BITS of metal and plastic don't get much fanfare, but the semiconductor materials market is approaching a $10 billion business. Sales of these materials came to $9.2 billion in 1991 and should reach $9.7 billion in 1992, according to Electronic Materials Report from Rose Associates in Los Altos, Calif. That puts the materials content at about 16.5% of the total $58 billion value of semiconductor devices expected to be sold worldwide in 1992.

Epitaxial wafers are the bright spot in an otherwise slow market for silicon wafers. Growth in leadframes will be in surface mount and etched frames. Leadframes for surface mounted devices are expected to see 20% growth for the next several years; sales of etched leadframes are expected to jump 19% in 1992, to surpass 20% of the total leadframe market for the first time.

—Paula Doe in Japan

TECHNOLOGY

Big brother (the high-tech version) is watching you

DID YOU EVER worry that your contribution to high-tech innovation would come back to haunt you? It has.

Welcome the "Electronic Attendance Board" by inventor James Shields of Haddon Heights, N.J., a device that automatically identifies the entry or the exit of individual employees.

The idea, says Shields, is to keep track of which employees are in the building, which are out on work assignments, and which workers are out on a break or at home—all with an electronic board.

The inventor will not reveal how his electronic people-watcher works because the patent is still pending. Shields got the idea for the product from his experience as a salesman. "I'd wait five minutes on the phone for someone and the secretary would come back to tell me the guy was on vacation," says Shields. "So I saw the need for something like this in the business world."

Perpetual latecomers and sneaky early departers don't have to worry for now; the high-tech attendance taker isn't in production yet. Shields is still looking for someone to license the idea for manufacturing. The editors at ELECTRONIC BUSINESS concur that this idea is a case of high tech run amok. But then editors are commonly known to be particularly tough employees to track down. . . and we want to keep it that way.

—E. B. Baatz

DISTRIBUTION

The recovery is here at last, say distributors

IF FIRST QUARTER distributors' sales and orders are any indication of the future for electronics sales, our forecasts are right on track. Cahners Economics expects distributors' shipments to push up 11.6% this year and orders to swell 13.4%. Unlike last year when sales and orders quickly petered out, this time expect double-digit growth to hold firm as end-market demand for components flourishes. In particular, U.S. semiconductor sales through distributors will also post strong gains, rising 10.5% this year.

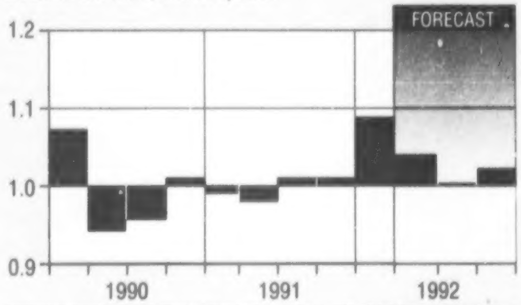
In the first quarter of 1992, distributors' new orders jumped 15.2% above the previous year's first-quarter level, the biggest such increase since 1990. Shipments also rose in the first three months of 1992, but at a more modest 9.6% growth rate.

The book-to-bill ratio for the nation's largest distributors has managed to hover above parity in each of the last eight months. In particular, the ratio hit an unexpected high of 1.11 in January, dropped to a respectable 1.04 in February, then rebounded to 1.09 in March. That performance is significantly better than the first quarter of either 1991 or 1990.

For electronic component and equipment manufacturers, the distributor data are more than just dry statistics. Remember, distributors are a leading indicator for the rest of the electronics industry. So start preparing for the next recovery.

—Julie Handelman-Sagan

Book-to-bill ratio, end of quarter



(Index: May 1980 =100)					FORECAST			
Orders	326	316	346	378	**378**	**359**	**378**	**408**
Shipments	324	315	334	350	**363**	**358**	**371**	**383**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
		1991				1992		1993

Source: National Electronic Distributors Assn.; Forecast: Cahners Economics

SEMICONDUCTORS

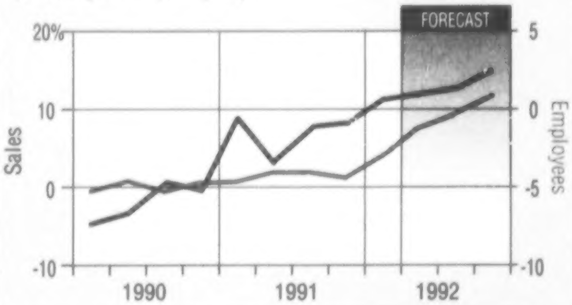
Chip sales rise briskly, but more layoffs are likely

U.S. CHIP manufacturers will likely see stronger gains this year after a disappointing 1991. Cahners Economics expects semiconductor sales in North America to reach $17.4 billion in 1992, 13.4% above 1991 sales. New orders should advance 14.7% this year to $18 billion.

Unlike last year, when the risk to the forecast was on the downside, the risk now appears to be all on the upside. Low interest rates and stronger investment in high-tech capital equipment should fuel demand for chips this year.

First-quarter data is right on target with these forecasts. In the first quarter of 1992, semiconductor sales climbed 12.2% above the previous year's level, while orders rose 13%. These were the best quarterly growth rates the industry has seen since mid-1989. The book-to-bill ratio swung between only 1.11 in February to 1.08 in March, somewhat disappointing relative to early 1991 levels. These data can be interpreted as relatively solid numbers, however, and do not indicate a bookings bust later this year.

(% change from prior year)



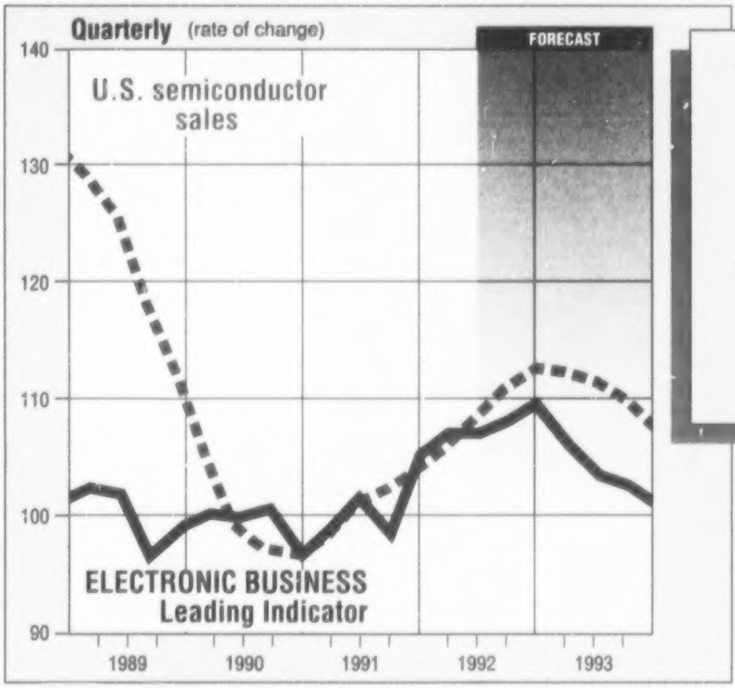
($ billions)					FORECAST			
Orders	4.15	3.66	3.98	4.45	**4.73**	**4.23**	**4.64**	**5.04**
Sales	3.83	3.86	3.90	4.25	**4.32**	**4.39**	**4.48**	**4.73**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
		1991				1992		1993

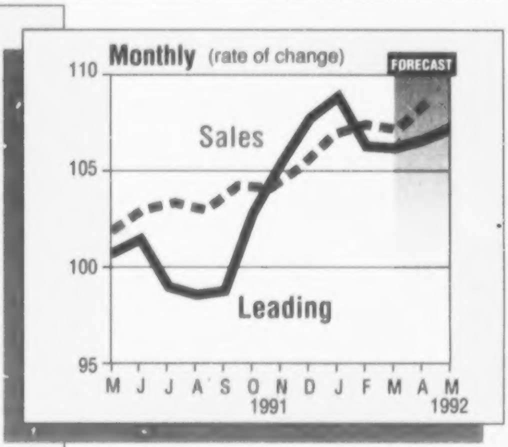
Source: Semiconductor Industry Association; Forecast: Cahners Economics

Although sales are enjoying a rebound now, employment isn't likely to pick up any time soon. In fact, following on the heels of 3% or more annual declines in employment in each of the past three years, employment by U.S. chip makers is likely to fall another 2% this year. The industry has already lost 41,000 jobs from its peak employment level of 262,400 in August of 1988.

—J. H. S.

ELECTRONIC BUSINESS Leading Indicator

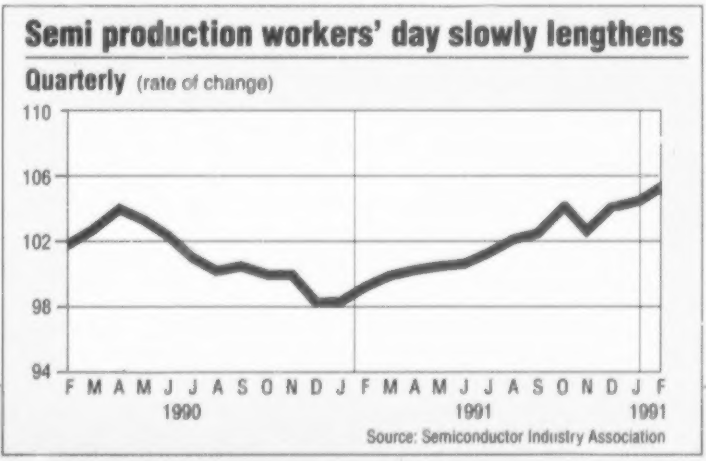




Indicator levels off in March

The ELECTRONIC BUSINESS Leading Indicator (EBLI) averaged 107.2 during the first quarter of 1992—a much better number than the 99.5 mark registered last year during the same period. Perhaps the most encouraging news in March is the continued expansion of semiconductor production workers' weekly hours—an indicator that may portend a resumption of new hiring in the year ahead. Look for the EBLI to remain near its present level for the next few months before regaining speed in the second half of 1992 along with the general economy.

—John Farrell



Semi production workers' day slowly lengthens

Source: Semiconductor Industry Association

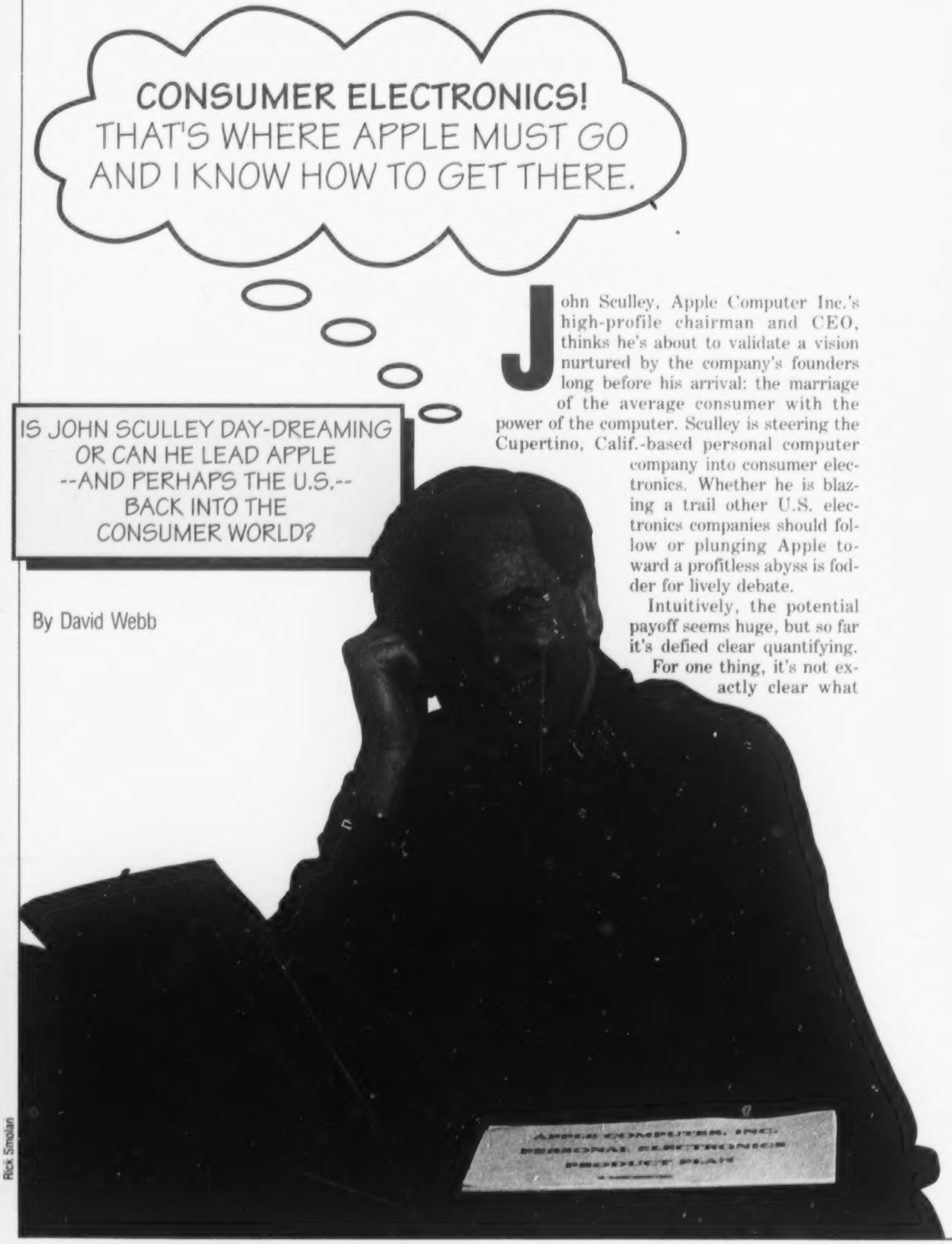
	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Mar.)	106.3	106.4	101.8	101.5
U.S. semiconductor bookings ($ millions, 3-month average, Mar.)	$1,528	$1,477	$1,383	$1,311
Weekly hours of semiconductor production workers (monthly average, Feb.)	42.7	42.3	40.9	41.1
Electronic components lead time index (1977 = 100, Mar.)	90.2	88.4	78.0	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, Mar.)	88.0	91.5	70.6	68.5
Change in electronic components inventories ($ millions, SA, Feb.)	$57	-$108	-$207	-$53
Contracts and orders for plant and equipment ($ billions, SA, Feb.)	$34.6	$35.4	$37.3	$35.0

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100

COVER STORY


CONSUMER ELECTRONICS! THAT'S WHERE APPLE MUST GO AND I KNOW HOW TO GET THERE.
APPLE COMPUTER, INC. PERSONAL ELECTRONICS PRODUCT PLAN

Rick Smolan

IS JOHN SCULLEY DAY-DREAMING OR CAN HE LEAD APPLE --AND PERHAPS THE U.S.-- BACK INTO THE CONSUMER WORLD?

By David Webb

John Sculley, Apple Computer Inc.'s high-profile chairman and CEO, thinks he's about to validate a vision nurtured by the company's founders long before his arrival: the marriage of the average consumer with the power of the computer. Sculley is steering the Cupertino, Calif.-based personal computer company into consumer electronics. Whether he is blazing a trail other U.S. electronics companies should follow or plunging Apple toward a profitless abyss is fodder for lively debate.

Intuitively, the potential payoff seems huge, but so far it's defied clear quantifying. For one thing, it's not exactly clear what

How the consumer market stacks up

Production by category for 1990 ($ billions)

Product	Europe	U.S.	Japan	Total world
Color TVs	$7.2	$5.1	$6.1	$27.0
Black & white TVs	0.0	0.0	0.0	1.4
Car audio systems	1.1	2.3	3.1	10.1
VCRs	2.2	0.1	7.4	12.0
Video cameras	0.1	0.0	5.0	5.6
Videodisk equipment	0.0	0.0	0.8	0.8
CD players	0.6	0.0	1.2	2.3
Tapes	2.4	3.0	3.3	10.0
Other	2.2	0.8	8.6	18.8
Total	**$15.8**	**$11.3**	**$35.5**	**$88.0***

*1991(est.)= $93 billion

Source: Electronics International Corp.

the products will be. For another, the marketing channel is unfamiliar. That said, many observers say the stampede by computer makers into this new world will soon start in earnest, and each new entrant will seek a unique proprietary advantage.

Apple wants to leverage its graphical user interface, which catapulted the Macintosh to success into "information appliances." These include something Sculley calls "PDAs," or Personal Digital Assistants—handheld computers with communications capabilities—as well as conventional desktop and notebook-size Macintoshes. Apple also plans to license home-grown software that will handle everything from easy programming for VCRs to ordering pizza through an interactive television network.

These are big changes, both for Apple and for the computer industry. Apple is already modifying its business plan to accommodate a consumer focus. Sculley recently restructured his sales organizations, adding a group dedicated to developing a consumer market sales effort.

"I think this is one of those rare moments when the industry is taking advantage of the change in the technology base," Sculley says. "It's a great opportunity for U.S. companies to make the most of [the growing use of] digital information."

Software expertise is clearly Apple's entree to the "new" market, but other U.S. strengths are in hardware as well. They include, for example, digital-signal processors, high-end microprocessors, mixed-signal ICs, and multichip packaging. One challenge is to identify which markets to attack first.

Apple is definitely not chasing the traditional consumer market. With recessionary blues being sung all around the world, conventional consumer electronics manufacturers are having a tough time selling traditional boxes such as VCRs, TVs, stereos, and CD players, analysts say. "Consumer product companies as we've known them aren't making money anymore," says London-based BIS Strategic Decisions analyst David Mercer. Future opportunities for electronics vendors are in versions of those things that are not only computerized—as many are today—but also optimize a growing digital communications infrastructure.

The first wave of these new information appliances is expected late this year and early next year from Apple, Hewlett-Packard, and their partners. Interestingly, although Apple and HP will deliver very different products, they both will try to capitalize on a convergence of digital processing with new communications capabilities. Until recently, telephones, television, and radio were strictly based on analog technologies.

Even now, the telecommunications infrastructure of the U.S. is undergoing a conversion to digital in both the huge terrestrial-based telecom network as well as radio-frequency (RF), cellular, and satellite communications networks.

Information appliances would combine RF communications, computer processing power, and user-friendly software to make portable and easier-to-use products for just about anyone. The products, in concept, would:

- be lightweight, use a generic microprocessor, an assortment of ASICs, and up to one megabyte of memory;
- have a screen and a pen stylus or touchscreen interface on a Walkman-size device;
- be able to communicate with other systems via a wireless single-chip modem with subscription information services that provide banking, shopping, and news as well as unit-to-unit communications services;
- likely cost under $500, plummeting to less than $200 over time.

Because the critical path to this new market is paved with requirements for advanced software for accessing and manipulating digital information, U.S. companies have a chance to establish an early lead and to maintain dominance in what is a new category of consumer goods.

"There are several interesting things happening here," says Jon Gayle, an analyst at Alexandria, Va.-based market research firm Information Workstation Group. "Vendors are taking consumer electronic [products] like televisions and leveraging their use, essentially making information appliances with easy user interfaces. It's happening because of the displacement of analog by digital."

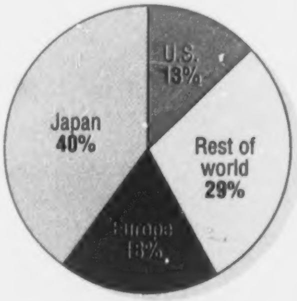
The U.S. Federal Communications Commission, in fact, will soon define HDTV standards that will have a dramatic impact on the rate of digital communications infrastructure development worldwide. Digital broadcasting—a likely component of the U.S. HDTV standard definition—will speed the proliferation of digital information and the acceptance of an entire new set of applications. Real-time or instantaneous viewer response to television advertisements is one example. Whether that's a benefit or a setback may depend on your buying habits and bank account, but whatever your view of its social value, it would not be possible using only analog-signal technology. Neither would ordering a pizza via the television screen and having it delivered in 30 minutes.

> **"We really want to become the Microsoft of the consumer [personal electronics] market," Sculley says unabashedly**

However big the market for these devices and services turns out to be, one challenge will be reaching an unfamiliar customer base. Both Apple and HP enter the consumer world with mostly computer-marketing experience. It's true that HP has had some consumer experience from selling its calculators, but they are typically expensive, feature-rich calculators targeted for college students and scientists, not the four-function, balance-your-checkbook crowd. Likewise, Apple is a neophyte to the rough-and-tumble environment of consumer electronics. It officially announced its entry into the consumer market last December and did so with just a hazy outline of what it intends to do beyond making Macintosh desktop computers "for the rest of us." Some industry watchers are skeptical about Sculley's rather civilized approach and if it can work in the cutthroat consumer world.

U.S. trails badly in consumer electronics

(U.S., Japan, and Europe produced 71% of the world's consumer electronics in 1990)



Source: Electronics International Corp.

"Apple's very broad-brush approach makes good copy, but it probably isn't a good business plan," says analyst Mark Stahlman at Alex. Brown & Sons Inc. He is critical of Apple's assumption that the convergence of communications, computer, and consumer technologies along with established consumer distribution networks will conveniently place operating-system software vendors such as Apple in a position of strategic importance. Stahlman quickly notes that Apple has only "produced talk" to date, despite financial commitments to new ventures with IBM, Sony Corp., and Sharp Corp. He claims those aren't product relationships but technology development relationships that are based on personal computer development. Unlike PCs, consumer electronics tend to be tightly integrated application-specific products; they aren't broadly functional the way PCs are, and they command a lower price as a result. "The challenge for Apple and everyone else is to think through new business [opportunities] beyond PC-oriented uses," Stahlman says.

"The key here is really software-intensive digital communications," says market analyst Walter Miao, vice president of technology at Link Resources Inc. "Apple is looking at the communications angle very intensely." Without the promise of a growing digital communications infrastructure, Miao says, Apple would be stunted in its quest to make its presumed handheld PDAs a commodity item.

Sculley seems to agree. "The biggest opportunity for PDAs are those applications built around communications," he says. Televisions and especially telephones will be "reinvented in the '90s," largely because analog information formats will be replaced by digital.

Apple's strategy provides at least one model for U.S. companies eager to compete in the consumer electronics market, which has for so long been dominated by non-U.S. companies.

Sculley, for example, readily acknowledges Apple will need a partner with consumer manufacturing and marketing experience to help design and build small, handheld PDAs. In this case, packaging design and manufacturing are critical issues. Sculley hopes to find that expertise in Apple's partnership with Sony, the giant manufacturer of consumer electronics goods renown for its expertise at cramming circuitry into small, attractive packages. The joint venture with Sharp is expected to produce "wizard-like" personal organizers with a Macintosh graphical user interface and stripped-down version of the Mac's operating system.

A company entering this market will almost surely have to rely on an established partner,

HP dips a toe into consumer waters

HEWLETT-PACKARD is another U.S. company warily entering the consumer electronics world. Its early strategy is to avoid the cutthroat margins so typical of commodity items and to concentrate on more profitable and pricey business.

"We're trying to be careful about conveying the perception that we are 'going after' the consumer market," says HP spokesperson Larry Sennett. "We'll make whatever the consumer will buy and whatever we can sell at the right price point," he says.

HP plans to build a VCR-size computerized transceiver that would be a primary television interface with interactive capabilities. In simpler terms, the box would be a computer that runs software to process real-time interaction with bank accounts, grocers, pizza restaurants, advertisers, game shows, or sporting events, among others. HP has partnered with Reston, Va.-based TV Answer Inc., which developed the interface software and will also be the licensing hub of a nationwide network of metropolitan service area providers. The service providers will broadcast these interactive services into users' homes through the HP-built unit.

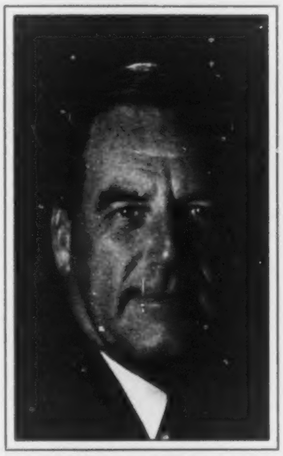
To appreciate how large HP expects this interactive TV service market to become, consider that HP is ramping up two manufacturing sites—one in Roseville, Calif., and the other in Singapore—capable of producing 1.5 million units yearly. These facilities should be ready before the end of next year, although HP says it won't begin production until a year after the Federal Communications Commission issues the first licenses to service area providers. That isn't expected to happen until this fall.

Some analysts think HP, despite its calculator/consumer market experience, will have difficulty penetrating the interactive TV gadget business, which depends heavily on marketing by service providers. "The TV Answer device will require marketing in channels different from those used to sell calculators. I don't see [HP] catering to Joe Six-Pack," says Walter Miao, a market analyst at Link Resources Inc.

Sennett doesn't "see it as a K Mart type of product for a while," at least the first year or two. Eventually, he says, TV Answer will wind up with the same channel progression as Nintendo, which was graduated over a 10-year period from niche electronics and toy retailers into the mainstream mass-marketer channel. Sennett said HP will probably start with computer superstores such as Fry's Electronics and electronics retailers such as Circuit City.

HP already has competitors in the interactive TV market, including Mountain View, Calif.-based Interactive Network Inc. and Frox Inc. of Sunnyvale, Calif. Interactive Network is providing an interactive TV service to subscribers in the Sacramento and San Francisco areas with plans to go into other major metropolitan areas this year. Users pay $200 for a broadcast "control box" similar to HP's and a $15 monthly service charge. The service enables viewers to play along with TV game shows such as "Jeopardy" and "Wheel of Fortune" and sporting events such as football, baseball, and basketball. Unlike HP's TV Answer service, Interactive Network, at least for now, is purely an entertainment medium.

Likewise, Frox's system is solely for the purpose of home entertainment, albeit with computerized features that make it as easy to use as possible. However, it's not cheap. For a mere $10,000 to $50,000, a consumer can buy a Sparc RISC microprocessor-based Frox entertainment system with full digital TV (not HDTV), laser video-disk player, digital audio-tape player, compact disk player, and fiber-optic wired speakers. □



Hewlett-Packard CEO John Young is concentrating on profits as HP enters the consumer market

according to Sculley, whether it's a manufacturer, marketer, distributor, or technology developer. "It's unrealistic to expect any one company to create a successful PDA business [as a hardware and software developer, manufacturer, and marketer]," Sculley says.

U.S. vendors will probably focus on one or two functions. The most likely scenario will be U.S. vendors using offshore manufacturing expertise to build hardware while developing and licensing software to run it, Sculley says. Much of that software development could come out of the publishing and entertainment industries, not conventional computer software application houses, he adds. Even more interesting is the likelihood that telecommunications companies such as the Regional Bell Operating Companies will play an important role in the application development for these new devices.

Apple has reorganized its once geographically segmented sales organization into four units: one targeting large customers and institutions such as schools and government agencies; another targeting small businesses; a third targeting K-12 education; and the fourth targeting consumers.

"A customer [-oriented sales organization] shift would have taken place, anyway," contends Tim Bajarin, president of Creative Strategies Research International Inc. in Santa Clara, Calif. Unlike conventional PC distribution for business applications, the mass-market channels need a faster, more precise response time to orders. "Apple is in the best position to capitalize on the PDA beyond the business market," says Bajarin. "They are the only company in the computer or consumer world that understands what's happening."

Bajarin cites four reasons why that is so:

- Apple understands the trend of analog-to-digital conversion of key industries, particularly communications;
- it understands the role of operating systems for so-called "hidden computers";
- it knows that consumer product architectures need to be scalable from a software standpoint;
- and it realizes the need to transcend PC application thinking into consumer-oriented mindsets.

"I don't sense the same level of understanding from Microsoft" about the personal electronics market, Bajarin adds.

Apple's consumer strategy is really a subset of what Sculley calls a "personal electronics" market strategy. Apple intends to help design handheld PDAs on which its operating system software will run with an easy-to-use graphical user interface—Apple's forte—included. It will then license its software and architectures to established consumer market manufacturers, that would build and market products to consumers. This is a big break from the past, when Apple was loath to part with proprietary technology in either hardware or software. Many observers think Apple could have captured a much larger chunk of the PC world had it been willing to license its architecture.

"We really want to become the Microsoft of the consumer [personal electronics] market," Sculley says unabashedly. "The biggest opportunity for us [to do that] is PDAs." Apple also intends to make such devices itself for a non-consumer market of vertical business applications.

Sculley explains Apple's PDA channel strategy as a three-pronged approach: First, mass merchandisers will distribute Apple and Apple-licensee PDAs; second, Apple will use its existing channels for sales of business-oriented PDAs; and third, Apple will sell into the information services market through or with service providers. That's an ambitious plan, and success is far from assured.

Apple is also dabbling in the more traditional entertainment market with General Magic in Mountain View, Calif. Apple has an equity stake along with Sony in the new venture. General Magic won't comment specifically about what it's doing, but analysts say the company is creating a handheld wireless portable interface for computers. Interactive TV would be one product made possible by these devices. Combined with hardware designed by General Magic and built by Sony, Apple supposedly intends to make its interactive TV interface as common as cable TV in U.S. homes. This is a strategy similar to Sculley's plan for PDAs. The most important use of the wireless technology, however, will be as a "window" to a remote desktop using a pen stylus and cellular or radio-frequency link, something analyst Sheridan Tatsuno of Neoconcepts Inc. in Rio Del Mar, Calif., calls a digital "communicator." Neither Apple nor General Magic will disclose when products will be available. ☐

CONSORTIA

Are they getting better?

Yes. It's been a painful process, but U.S. R&D consortia are finally producing results

By Peter Burrows

Consider the state of research and development in the U.S. The traditional R&D drivers—the Defense Department, the central labs of companies such as AT&T and IBM, and universities—are all withering under funding pressure. Shrinking profit margins are forcing many companies to focus their in-house efforts on applied projects with short-term payback. Add to that the skyrocketing capital requirements for long-term product development and manufacturing capacity, and it's easy to understand why even the largest players are teaming up with competitors to help share costs and disperse risk.

The big question is how best to cooperate. One controversial solution in the U.S. has been R&D consortia, in which private companies share ideas, personnel, and capital to develop technology to spur the competitiveness of all. "How else can you have a staff of Ph.D.s doing research that you get to direct for a small fraction of the cost, without even having to worry about hiring and firing and all the rest?" asks Terry Krinke, manager of quality and technology for Control Data Corp.'s government systems manufacturing division.

Yet, while that may sound great, R&D consortia haven't really caught on. Only 60 of the 20,000-plus electronics companies in the U.S. are full shareholders in the industry's three major efforts—the Semiconductor Research Corp. (SRC), the Microelectronics and Computer Technology Corp. (MCC), and Sematech—and controversy, lack of member commitment, and a scarcity of clear results have marred these efforts to varying degrees.

In fact, only 36% of 455 CEOs surveyed recently by ELECTRONIC BUSINESS and Ernst & Young expect to increase their participation in consortia over the next five years—the lowest percentage of the nine different partnering schemes listed in the survey.

Do the poor early results and widespread negative feedback mean the U.S. should dump consortia as a tool for competitiveness? The answer is no—or at least not yet. Having survived difficult infancies, Sematech, SRC, and MCC are now stable, maturing organizations. While their dreams have been scaled back, their efforts are starting to pay off, and all three are working to implement key lessons learned in their formative years. Some specifics:

- SRC, which just celebrated its 10th birthday, continues to impress members with its ability to coordinate the nation's university research into silicon-based technology. It now funds about half of all such research in the nation, with over 100 research contracts at 72 different universities;
- MCC, also created in 1982 to main-

tain the nation's lead in computer technologies, has taken strong steps to counter the claim that it is incapable of delivering commercially useful results. Payoffs from its more ambitious projects are still years away, but a rising tide of software tools and new production and packaging technologies are flowing from its Austin facilities;

- Sematech, after a series of midcourse corrections, has settled into a more realistic strategy to improve the semiconductor manufacturing infrastructure that has quelled much of the criticism it suffered during its first five years. Members say these efforts have enabled them to buy more U.S.-made equipment than they expected. Intel, for example, bought 50% of the equipment for a new fab from U.S. sources rather than the 30% it had expected, while Motorola bought over 80% American for its new MOS-11 fab instead of the 25% it had planned for.

WHAT'S CHANGED? For starters, these consortia had to overcome some deep-seated biases within the American psyche. Rather than assume the product development burden of their members, they have had to limit their scope to more generic R&D. Cooperation between competitors to develop products for mutual benefit and for the good of the country sounds fine on paper but didn't translate well in a nation of capitalism purists. The privileges of membership—federal funding and the increased ability to influence industry direction—clashed with America's devotion to self-betterment and level playing fields. The founding fathers' wide-eyed love of big goals heightened these tensions. Sematech, at least initially, thought it was on a Messianic mission to save an industry.

All three are responding to these biases, building uniquely U.S. versions of consortia in the process. They ask their members to share, but only so much and only when it doesn't put them in head-to-head battle with each other in the marketplace. Plenty of kinks remain to be worked out, but progress has been made, as a look at all three reveals.

SRC, based in Research Triangle Park, N.C., was from the start best positioned for success. Its goals were more modest and less likely to raise member concerns about losing proprietary knowledge. Rather than save the U.S. semiconductor industry, which was Sematech's much-heralded charter, or maintain the nation's dominance in computer technology, which was MCC's reason for being, SRC had a more bounded purpose. It hoped to coordinate and promote research on silicon-based technology and to build up the stream of new ideas and engineers flowing from universities into the chip business.

So far, SRC seems to have delivered. In 1982, the shift of U.S. university research programs from silicon to other materials left only 25-or-so graduate students working on silicon-based projects. Today, there are more than 600 students involved in SRC-funded projects, and close coordination with SRC member companies has helped faculty focus on areas of the highest commercial interest. Perhaps best of all, a 500-person mentoring program has helped member companies capture the fruits of this research. Advanced Micro Devices Inc. in Sunnyvale, Calif., for example, recently picked up modelling technology from the University of California at Berkeley that significantly sped the adoption of advanced photolithographic processes.

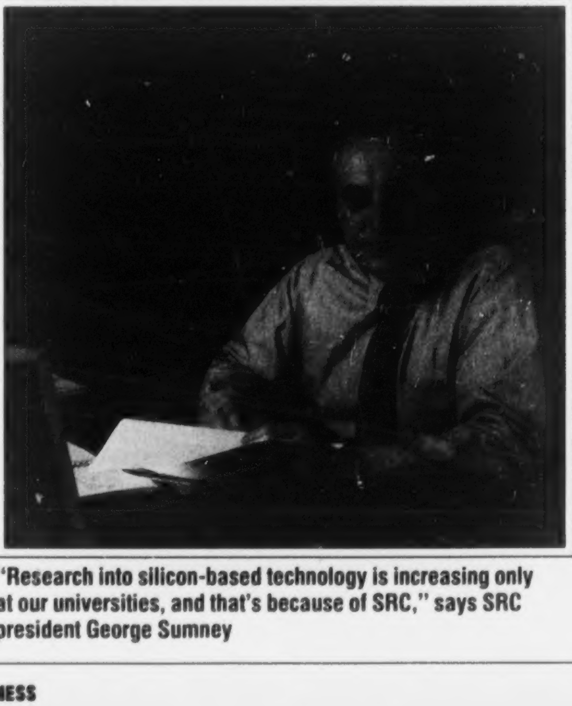
"The only place research into silicon-based technology is increasing is in our universities, and that's because of SRC," says SRC president George Sumney. "Plus, we now have the strongest link between industry and the universities that exists anywhere in the world."

Observers confirm this bullish assessment. "We have invested about $2 million in SRC and $20 million in Sematech, but we get about the same value from each," says Court Skinner, R&D director for National Semiconductor Corp. IBM has hired more than 70 engineers who have participated in SRC projects, SRC sources say.

Even consortia-bashers, such as Cypress Semiconductor president T. J. Rodgers, give praise: "SRC would be one of the first I would join if I had the money to invest."

Much of the credit goes to SRC's decision to minimize rather than maximize its assets and focus. "From the start, we decided to use existing teams, capabilities, and facilities wherever they existed," says vice president and chief scientist William Burger, who spent 20 years with R&D contractor Research Triangle Institute before joining nascent SRC in 1982. "We didn't want to create our own empire."

With only 12 full-time staffers working from a humble office, SRC is a model of efficiency—vastly different from 700-plus person Sematech, which lobbied hard in the early days for funding to build a state-of-the-art fab of its own. Moreover, SRC's modest government funding—just 5% of its $37 million annual budget—lets it



Allen Weiss

"Research into silicon-based technology is increasing only at our universities, and that's because of SRC," says SRC president George Sumney

avoid the public limelight and enables it to work harder and less self-consciously to serve its members' needs. Sematech, on the other hand, must constantly justify the national benefit of the $100 million it gets from the DOD's Defense Advanced Research Projects Agency (DARPA) each year. MCC is somewhere in the middle, getting about 20% of its $55 million budget from competitively won Defense Department contracts.

DURING the past two years, MCC and Sematech have begun adjusting to the realities that made SRC a success. New leadership is partly responsible for the change. Since Craig Fields left DARPA to head MCC and William Spencer became Sematech CEO in mid-1990, both organizations have de-emphasized broad mission statements and now focus on more narrowly defined goals:

- MCC recently announced a 10-year-plan that focuses primarily on two areas—a high-value electronics division that develops packaging, interconnect, and display technology, and an enterprise integration division dedicated to building a global data-highway and accompanying networking and database technologies to bring departments and companies closer together;
- Sematech now seeks to improve the quality and reliability of the equipment and materials its members rely on—a far cry from its original charter. "Sematech's first plan was to actually build DRAMs to learn about manufacturing and then grind them up at the end," scoffs Arita Prabhakar, director of microelectronics technology at DARPA, who describes relations with Sematech in 1988 as "hostile." "They're a million miles from that now, and I'm delighted with how they've shifted."

Consortia comes up last in CEOs' partnering plans ...

(% expecting to increase activity in next five years)

Marketing agreements	81%
Technology licensing	77
Joint product development	77
Distribution agreements	72
Comprehensive joint ventures	58
Research partnerships	58
Manufacturing agreements	58
Equity investments	54
Consortia	**36**

... and here's what consortia CEOs are doing about it

Focus on precompetitive R&D. Rather than develop next-generation product technologies, Sematech and MCC are working to improve the supplier infrastructure and to develop standards. This widens their appeal, and makes them less threatening to companies who feared sharing proprietary product technology.

Coordinate more, invent less. By pushing actual R&D out to the members' labs, consortia save money and improve the likelihood that findings are actually commercialized.

Act like a company. With members demanding a quantifiable return-on-investment, consortia are instituting business-like processes and procedures to increase and concretely prove their worth.

Source: ELECTRONIC BUSINESS/Ernst & Young

Both MCC's and Sematech's new agendas are increasingly focused on precompetitive R&D—areas that offer industry-wide benefit without providing new product technology with which members can directly compete. This occurred for good and bad reasons.

On the down side, both consortia learned the hard way that U.S. companies are not ready to share key technologies. Sematech's early history illustrates the point. With Japan in the process of stealing huge chunks of the U.S. chip market, many Sematech insiders say the consortia got off to a fast start on its original plan to develop processes to build 64-Mb DRAMs and other critical components. IBM and AT&T donated key process technologies, and founding fathers such as Robert Noyce and Charles Sporck convinced Congress to provide the funding to build its own fab to support the effort.

"There was a sense of desperation in the industry that convinced us to take a leap of faith and look at it from a patriotic standpoint," says LSI Logic Corp. vice chairman George Wells. "We knew we'd have problems working with competitors, but we all decided to get our shoulders behind the same wheel and not let the Japanese eat our lunch any more."

Problems soon overwhelmed that idea. Members began to refuse to share their best people or proprietary know-how. Multifaceted partnerships between members and foreign competitors, such as AT&T's links with NEC and Texas Instrument Inc.'s joint work with Hitachi Ltd., exacerbated the problem. Those that were willing to share reportedly demanded intellectual property protection assurances that stymied efforts to make use of their contributions. It was a Catch-22.

The shift to precompetitive R&D has eased member's concerns about revealing too much to competitors—either foreign or domestic. On the positive side, this change has extended the potential benefits of consortia to the industry at large.

RECOGNIZING THIS, management at MCC and SRC have changed their dues structures to allow companies to have non-voting participation in particular projects at reduced rates. Small companies can now get involved in MCC projects for as little as $5,000, down from $20,000 in the past—and can even pay with stock if they lack the cash. SRC's lowest fee is just $500. Full equity shares in MCC cost $250,000, plus additional annual dues for particular projects. Annual fees for SRC members range from $65,000 to $2.8 million. Sematech has no plans to alter its dues structure, which requires a minimum annual fee of $1 million.

Most importantly, the move to generic research lets them focus on the issues that most help members, consortia executives say. Rather than provide technology to build this year's better mousetrap, the argument goes, why not provide the core capabilities to help members provide any mousetrap faster, better and more efficiently. “The name of the game is no longer to develop some unique product and keep it from the competition for 10 years,” says MCC CEO and president Fields. “The real key is being able to provide a little better quality, reliability, time-to-market, cost, and product diversity. It's sustaining the small business advantages that leads to competitive success rather than failure.”

With that in mind, Fields has steered MCC in a variety of new directions. One is to develop a data communications highway called EINet and related services to enable business partners to speed up their interactions and to cooperatively develop products. MCC is also increasing its focus on standards development, and is making itself available to members to do market trial studies to try out new products with other members before ramping up for the general market.

But that's not all. Like Sematech, MCC is working to create a network of relationships between companies at various levels of the food chain to ensure a healthy industry infrastructure for its shareholders. Where a stable U.S. supplier does not exist, MCC has provided venture funding to fill the gap; in three instances where no vendor existed, it has spun-off internal groups.

While these are new wrinkles for consortia, they fit into MCC's dream, says chief operating officer and executive vice president Alan Salisbury. “To create a technological engine of change for our members, and to be a proactive force that helps knock down barriers in markets by creating standards and healthy suppliers.”

Still, the move to precompetitive R&D is a retrenchment—making it more clear than ever that consortia will not be a panacea for industry woes. As such, many original consortia members, wary of efforts that don't directly relate to their plans, are demanding proof of the benefits.

LSI Logic, unsatisfied with the evidence, chose to resign from Sematech in January. A key gripe was Sematech's direct investment in critical suppliers. “Its a long stretch from developing world-class process technology to being a venture capitalist for struggling equipment-makers,” says LSI Logic's Wells.

Unlike their pioneering predecessors, the current generation of executives at Sematech and MCC have made a high priority of proving their organization's real worth.

“My sense is that Sematech was formed out of a sense of panic fueled by a burst of patriotism,” says Sematech chief administrative officer Frank Squires, another former Xerox executive who followed Spencer to Sematech last April. “Chip companies were in a free fall and so took it as an article of faith that [forming a consortia] was the right thing to do—to do what the Japanese and the Europeans did. Now that we've stopped the market-share erosion and have some years under our belt, members are very appropriately looking at their return from a financial perspective.”

MCC's dream: to spur members' competitiveness, drive standards, create healthy suppliers, and be an “engine of change,” says COO Alan Salisbury

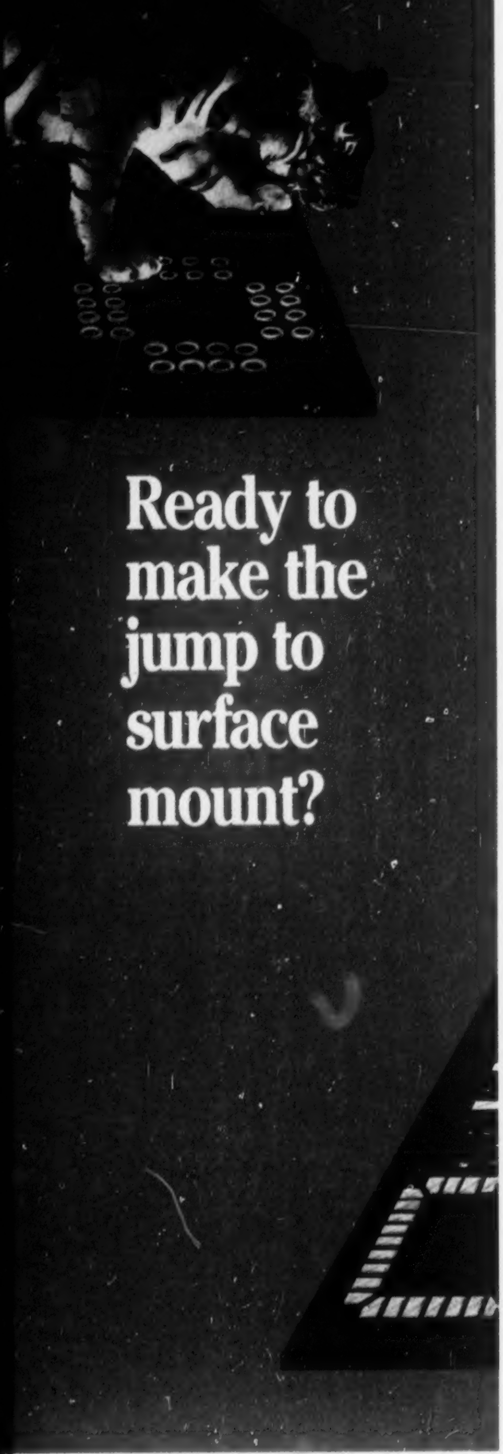
With that in mind, Sematech plans to deliver a customized return-on-investment analysis to each member by year's end. While Spencer estimates that most members now receive a positive but meager ROI—and that does *not* consider such intangibles as improved infrastructure or industry cooperation—his goal is to provide an annual return approaching 10% by 1994. “If Sematech is not providing a reasonable benefit, then the members should not stick with us,” he says.

To ensure it does bring benefit, Spencer has made internal operations the number one focus for 1992. “Cost efficiency and urgency have not been high enough on the list.” Already, he claims that efforts have improved Sematech's on-time performance from 50% last spring to over 85% at the end of the year. Agrees LSI Logic's Wells, “Sematech is a much more businesslike place under Spencer. Timetables are very tight, and there's a sense that it's being run like any good company should be run.”

Fields has attempted to do the same for MCC. “There may have been some theological fervor at the beginning, like there is at the start of anything new,” he says. “But if there's one message I try to drill home, it's that I don't want anyone to be in MCC if they think it's a charity or because they ‘like consortia.’ I want them to be in MCC because they are going to get business benefit.”

Another measure of success for consortia is membership growth. By that measure, MCC must be doing something right. While it has attracted only two new full shareholders in the past two years, the number of nonvoting associate members—lower dues for narrowly restricted participation in specific projects—has swelled from six to more than 50 since 1988. Also, long-dormant members are considering becoming active again. One example is Control Data Corp., which had wound down its involvement in MCC projects from 3 assignees in 1985 to zero by 1988 but which may now send some people again, says CDC's Terry Krinke.

Whether employees of CDC—or anyone else—will want the job is another matter. Attracting key people to consortia has long been a problem. Accepting such an assignment has meant removing oneself from the corporate ladder—a problem quite apart from reluctance by companies to send their top staffers. “There are clearly cases where members send warm bodies to meet their


Ready to make the jump to surface mount?

contractual obligations," says one MCC full-time employee.

At one point in 1983, former chief Bobby Ray Inman publicly complained about the poor quality of the assignees being sent to fill the seven vice president spots and admitted to rejecting most of those suggested. Fields says those days are gone. "Yes, I would like more assignees, but I have no problem with the quality of those I do get," he says. "Even in these recessionary times, our people get jobs within 15 minutes of leaving here."

Sematech was formed out of a sense of panic and a burst of patriotism

Consider the case of Advanced Micro Devices, a Sematech founder. It was much criticized for not looking out for assignees' careers in the early years. Today, AMD provides a mentor for each of its 20 assignees. "There's a waiting list from internal groups that want to hire them," says AMD senior vice president and Sematech board member Gene Connor.

Many companies have replaced the bulletin-board approach to finding willing assignees with a more proactive selection process designed to get the right person for the job. Most Sematech members also have assigned full-time employees to transfer technology within their companies, as well as mentors for each assignee; that way, the company gets to take advantage of what the assignee has learned, and the assignee feels less out of the loop with the home office. Other members are still in transition. "I don't think we put enough into it," says a source at National Semiconductor. "It's taken a while for people to get interested, but it's coming around. We have 20 people down there, but we still have to pay our 'sweat dues.' "

"You need people at the consortia, but you also need people back here who are ready to receive that technology," says Sharon Lipp, Digital Equipment Corp.'s senior manager for technology development programs, including SRC, MCC, and Sematech. Like other consortia users, DEC has a wide portfolio of "trust building" measures to ensure that consortia's output are exploited, such as newsletters, regular phone calls with managers, quarterly meetings of all assignees and managers, and periodic site visits. Harris Corp. requires all of its plant managers to visit Sematech yearly to learn what technology might be useful.

Sematech is working on its end to make itself more useful. Its Quality Assignee program, for example, helps members determine when and where to send assignees so that they get the most out of the project. Rather than assign employees to arbitrary two-year terms, members are encouraged to coordinate assignments with the beginning and end of new projects—that lets assignees get in at the ground floor, not waste time looking for something to do, and it ensures that they take something of value back to the employer, says Squires. Sematech is also doing a re-entry study that tracks the careers of former assignees.

RATHER THAN fight the natural tendency to keep one's best people at home, MCC and Sematech are following SRC's lead by pushing much of their development work to member sites. That helps solve the personnel problem, encourages rapid transfer of technology, and promotes industry cooperation by forcing members to play host to suppliers and even competitors to work on areas of common interest.

"I agree with those who say that 'the best technology transfer is done by moving people,' " says MCC's Fields. He points to MCC's First Cities program, in which certain members are working to deliver interactive, multimedia communications to 200,000 sites around the nation by mid-decade. "We have very few MCC employees working on this and very little MCC money is involved, but it's generating a lot of excitement with members. Frankly, that's a great way for consortia to work—let the work be coordinated by the consortia but done by members." ☐

CONSORTIA

Start-up no more, Jessi gets down to business

Europe's chip consortium has met its early goals but now must cope with internal squabbling and radical cuts in government funding

By Barbara N. Berkman

In both structure and purpose, there exist vast differences between the Joint European Submicron Silicon Initiative (Jessi) and Sematech, its U.S. counterpart. Founded to make Europe more independent of U.S. and Japanese semiconductor and production equipment suppliers, Jessi is more democratic than Sematech—there is no membership fee, and small companies abound among Jessi's 150 research facilities. And despite persistent funding shortages, which one Jessi source says affects 80% of the projects, the consortium seems to be weathering the kind of internal squabbling that has plagued Sematech almost from its inception.

Jessi was formed in 1989 to beef up Europe's semiconductor independence and accelerate research in submicron technology and manufacturing. As originally conceived, the consortium was to receive 25% of its budget from the European Community (EC), 25% from national governments, and 50% from industry.

The collaboration revolves around four subprograms:

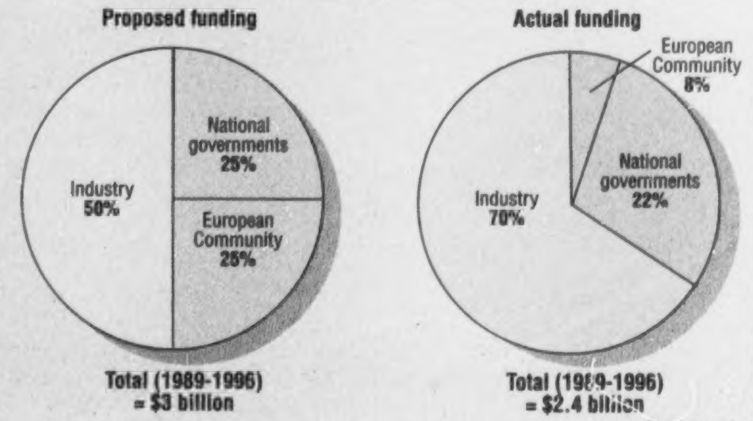
- Manufacturing and technology for engineering samples of 16-megabit and 64-Mbit DRAMS, 4-Mbit and 16-Mbit SRAMS, and EPROMs;
- Design and technology to shore up the presence of European materials, back-end processes, and production equipment in the world's fabs;
- The applications program, which encourages European CAD software;
- Basic and long-term research projects, including 0.25-micron CMOS technology, circuit design methodology, and lithography and other processing methods.

Specific results of Jessi aren't due until 1996, so any verdict on its progress is premature. Two years into the $2.4 billion program, however, Europe-based observers at most U.S. semiconductor companies are unimpressed. "We haven't seen a lot of activity from Jessi," says Daniel S. Lankford, chief executive of AT&T Microelectronics Europe. To be fair, though, Jessi is in fact just closing out its start-up phase. "The intention all along was to use that period to plan how we wanted to proceed," explains Klaus Knapp, Munich-based spokesman for the consortium. "It would have been impossible to do everything right away."

From that perspective, Jessi is only now getting under way. Several projects that had been run in parallel are now being rearranged into 15 new research "clusters," including HDTV, digital audio broadcasting, broadband communications, and other distinctly European applications. "On the main projects, such as the 64-Mbit DRAM, we're on time," says Knapp. Jessi also has produced the first silicon for 16-Mbit DRAMs (by Siemens), the first 16-Mbit EPROMs (by SGS-Microelectronics), design techniques for 0.7-micron logic chips, and equipment by ASM Lithography BV, based in Veldhoven, the Netherlands, to be used in a Jessi production unit.

Jessi certainly is not without its woes or its critics. For one thing, the consortium is hobbled by chronic

Industry picks up government's Jessi tab



Source: Jessi

funding shortages. The European Community has coughed up only $40 million—8% of Jessi's funding rather than 25%—and national governments have stinted on their commitments. The result is a budget that falls $600 million short of the original proposal. European electronics companies helped by kicking in 20% more than they had planned, but industry's coffers are clearly strapped: Hard economic times forced Philips Electronics to withdraw from Jessi's SRAM project last year, for example, although the company remained in 20 other programs.

Other projects also have been compromised by the deficit. By late 1990, the equipment/materials program had consumed three years of funding in only two years, effectively shutting the door on any new proposals. Basic and long-term research "received a very small fraction of the [budgeted] money," says program chairman Ronald A. Lawes. That forced a halt to one of its most important projects, 0.25-micron CMOS research. In another program, Siemens Nixdorf Information Systems is footing its own bill in a CAD project for PCB design after funding by the German government fizzled.

Jessi's critics also charge that the consortium is being weakened by the growing interdependence of members in other types of alliances. The DRAM agreement between Siemens and IBM created a political uproar at Jessi, for example, although others see that alliance as a way to conserve Jessi's resources by tapping IBM's expertise in X-ray lithography. "Jessi was never intended as the one and only [form of] cooperation," says Erik Kamerbeek, chairman of Jessi's equipment program.

Others claim that Jessi's technological advances are being compromised by political xenophobia that makes no commercial sense. Anti-Japanese protectionism led Jessi to eject ICL Ltd. from three of five CAD projects after the British computer maker was bought by Fujitsu Ltd. Jessi labeled ICL "foreign-owned," even though IBM Europe was allowed into two Jessi projects.

Jessi's achievements ...

Since its 1989 start-up, the consortium's members have:

- Released first silicon for 16-Mbit DRAMs, 16-Mbit EPROMs
- Approved 0.7-micron production technology
- Developed first 0.25-micron structures
- Introduced CAD frame system for automated chip and board design

... and ambitious goals

By 1996, Jessi plans to:

- Launch 0.5-micron pilot production
- Produce first 0.3-micron silicon and engineering samples
- 0.3-micron pilot production during 1996
- Equipment prototyping and verification for 0.3-micron process

Source: Jessi

Jessi certainly is not without its woes or its critics. For one thing, it is hobbled by chronic funding shortages

The consortium has paid off for many of its member companies. For example, Jessi membership releases up to $1.3 billion in British government funding to Britain's Racal-Redac during the first 18 months of a five-year CAD project to develop design tools for complex boards.

"Without the money, we might have gone in that direction, but we wouldn't have progressed as fast," says Roy Davies, who heads Racal-Redac's participation in this CAD project. He estimates the Jessi membership means Racal will commercialize the tools 30% to 50% faster than if it had proceeded alone. Jessi's joint-research structure gives Racal the elbow room to take more risks in development, he adds, and provides a forum for bringing European users into the development process.

ASM Lithography also has benefited from Jessi, particularly from the consortium's emphasis on bringing together manufacturers and end-users in joint development. The company received its first order for a PAS 5500/90 deep UV wafer stepper and i-line system from IBM's German subsidiary, which will use the equipment in a Jessi project to test and improve a photolithography cluster tool for 0.35-micron processing.

The payoff for ASM Lithography consists of more than an order from IBM, however. The company also is counting on end-user feedback on the new stepper from other project members—including SGS-Thomson, Siemens, and Philips—so that it can fine-tune the equipment for the world market.

Yet to be seen, of course, is whether Jessi will give European companies a badly needed bigger share in the global chip and equipment market. For the near future, at least, most observers are doubtful—especially when it comes to equipment, which is heavily dominated by the U.S. and Japan. Siemens's semiconductor unit, for example, spends only 20% of its $200 million annual equipment budget on European equipment, compared with 55% on U.S. vendors and 25% on Japanese equipment.

The European equipment that Siemens does order is of relatively minor strategic importance, according to Winfried Ruttenauer, senior director of manufacturing engineering at the Semiconductor Group. Jessi may one day change that, he adds, but not in the near future.

Given its funding and organizational shortcomings and the inevitable political and cultural clashes, it would be easy to dismiss Jessi as a serious competitor in world semiconductor technology. That would be a big mistake, warns Sematech spokesman Buddy Price in Austin. "Don't sell it short," he advises. "All you have to do is look at Airbus—the world's second-largest aircraft manufacturer—to see what European consortia can do when they put their minds to it." ☐

100
FASTEST GROWING COMPANIES

Is this any way to sell computers? Zeos thinks so

Hawking unglamorous but reliable machines by mail, plus nimble service, has made it 1991's fastest-growing electronics company

By H. Garrett DeYoung

If you're thinking about buying a new personal computer, chances are you've already set a few ground rules. One, the name on the box is unimportant—any PC is practically identical to any other PC of the same specs. Two, the purchase itself will be no more intimidating than ordering a pair of socks from the Lands' End catalog. And now that computer makers are treating the masses with a little respect, you demand that even the most vanilla PC comes with full service and support.

That kind of thinking is music to Greg Herrick's ears. As chairman and CEO of Zeos International Ltd. in St. Paul, Minn., Herrick has made the company one of the nation's top direct-mail vendors of high-performance Intel-based computers and workstations. From 1988 sales of a mere $11.8 million, Zeos revenue rocketed to $127 million in 1990 and $231 million in 1991; net earnings soared from $234,000 to $10.3 million during the three-year period. The company's average annual growth rate during the past five years now stands at 188.7%, putting Zeos at the top of ELECTRONIC BUSINESS's 1991 list of fastest-growing companies.

To some degree, Zeos has prospered by acknowledging—indeed, touting—a basic weakness in the PC marketplace: The products have become not just commodities but "disposables," argues Joan Lappin, president of Gramercy Capital Management Corp. in New York. Marketing gimmicks notwithstanding, the distinctions between one computer and another are all but invisible thanks to rapid technological advances, intense domestic and foreign competition, and free-falling price-tags. Today's savvy users "don't need an IBM logo on the machine," says Herrick. As the mystique fades, he adds, buyers see mail order as a safe, convenient alternative to traditional channels.

Steve Woit

"We need to work more on the repeat sales that account for up to half our business," says Zeos CEO Gregory E. Herrick

No one knows, of course, whether Zeos can maintain its frantic growth rate or for how long. For one thing, Herrick admits that margins are being squeezed by price-cutting and heavy mail-order competition—not only from players such as $890 million Dell Computer (25th on this year's fastest-growing list), Northgate Computer Systems, and Gateway 2000, but also from heavyweights IBM and Compaq. For another, a few rough spots lately suggest that Zeos may be trying to do too much too soon.

For now, customers fairly leap at the chance to gush the company's praises. "I've been very happy with Zeos equipment," beams Lappin, a recent convert from AST Research. "If they told me about a new product I could use, I wouldn't hesitate to send off a check." Industry analyst Clint Morrison, vice president and senior research analyst at John G. Kinnard & Co. in Minneapolis, is no

Zeos International at a glance

Fiscal year ended Dec. 31	1991	1990
Sales (thousands)	$230,913	$127,098
Net income (thousands)	$10,286	$4,205
Net income/ sales	4.5%	3.3%
Cost of sales/sales	76.2%	79.0%
R&D/sales	0.9%	0.2%
Marketing sales	12.3%	11.1%
G&A sales	3.8%	4.0%
Number of employees	744	549
Sales per employee	$310,367	$231,508
Net income per employee	$13,825	$7,659
Capital expenditures/sales	1.2%	1.4%
Current ratio	2.69	1.44
Debt/equity ratio	0.00	0.42

Source: Company reports

less glowing. "[Direct mail] is the most cost-effective way of getting computers into the customer's hands," he says. "Zeos is at the top end in terms of product quality and customer service—there's no question that the company will continue as a major player."

Zeos was launched in 1981 as a producer of radio transmitters for real-estate agents. When that business was sold in 1985, the founders turned to computer production to take advantage of their expertise in parts distribution and contract manufacturing of motherboards for Intel-based computers. The company now has an electronic-design subsidiary (PC Tech, acquired early this year) and a contract manufacturing unit, and distributes passive electronic components through a division dubbed Parts 1. Zeos went public in 1987.

If Zeos has a clear overall strategy, it seems to be simply to rapidly capture market share and establish its name before the direct-mail field gets too crowded. "People are getting into this simply because it's a proven strategy," says Herrick, who cut his direct-marketing teeth with Fingerhut Corp., the Hopkins, Minn.-based catalog retailer. Zeos hence relies heavily on multiple color ads in leading PC publications to get its competitively priced notebooks and 386 and 486 PC's into as many hands as possible. Herrick estimates that about 15% of the company's customers are home users, about 60% are small and midsize businesses, and some 5% are foreign buyers; the rest are distributed through government and academia.

Herrick and others realize that it takes more than convenience and low prices to win customers. "To be a player these days, you need really good machines," says analyst Morrison. So Zeos pushes its system upgradability, its use of big-name components—microprocessors from Intel, support chips from VLSI and Chips and Technologies, drives from Seagate and Conner Peripherals—and the more or less obligatory free software.

Buyers seem to be especially taken by Zeos's attention to basic marketing principles. Purchases may be charged to a major credit card or to Zeos's own revolving-credit card. Delivery is "very fast," according to Lappin, and Herrick promises to make it even faster. Beginning this year, he vows, all orders will be shipped within 48 hours; orders for standard configurations that are received by 1 PM will be shipped the same day.

The company also gets high marks for its customer support and service through a 24-hour toll-free number—the industry's first, according to Herrick—when problems do arise. "I can't think of a single case in which they didn't solve my problem," says Lappin. Adds Scott Uhrick, senior analyst at MBIA in Armonk, N.Y., "People ask me why I'm buying Zeos when I could buy from Hong Kong for $200 less. The reason is that I like their service on those occasions when something arrives broken." The 250-employee insurance company has bought about 120 Zeos PCs and notebooks during the past year.

Even with such rosy testimonials, Herrick says that Zeos could be doing some things better. One is to start targeting some of the company's advertising to previous customers. Those buyers now make up 30% to 50% of Zeos's current business, Herrick estimates, "even without promotion directed specifically to them." Also on the burner for Zeos this year is an organized push into international markets, where rival Dell Computer is much stronger. Herrick concedes that the company "hasn't made it easy for foreign customers to do business with us, but we wanted to be sure that everything was in place [in U.S. markets] before we take on overseas sales."

The idea that Zeos is setting its sights on new markets concerns some observers who wonder if the company isn't already struggling with the fairly minor, but still irritating, glitches that accompany rapid growth. Herrick says that production lagged demand briefly during last year's new-products transition, although he says the company rarely fell more than a week behind schedule. And money manager Lappin recalls a Zeos shipment that was lost for several days before it was delivered. "My impression was that they didn't have the people to track it down," she says. Herrick notes that such problems are now being addressed with new key personnel, a doubling of production capacity, and new telephone and MIS systems.

Analyst Morrison, meanwhile, has some qualms about Zeos's advertising and promotion expenses, which he says hit $9 million during the last quarter of 1991—12.7% of net sales. While Morrison credits Zeos for its aggressive spending in a soft market, "you also have to question the marginal effectiveness of those last few pages of advertising."

Unfazed, Herrick claims that the company simply can't afford to cut back on its marketing. He likens the PC business to the auto industry, in that everyone owns at least one. In such cases, market expansion is driven only by developing—and promoting—the features that set one product apart from another. Says Herrick, "It is these new features, such as pen-based systems and multimedia, that will keep this market growing for a long time." ☐

100
FASTEST GROWING COMPANIES

Electronic Business

Rank 1991	Rank 1990	Company Location	Five-year sales growth* (%)	Fiscal 1991 sales ($ millions)	Fiscal 1991 profits ($ millions)	Fiscal year ended	Industry segment
1	—	**Zeos International** St. Paul	188.7%	$230.9	$10.3	12/91	computers
2	—	**Sybase** Emeryville, Calif.	169.0	159.4	7.0	12/91	software
3	—	**SynOptics Communications** Santa Clara, Calif.	167.0	248.3	26.8	12/91	communications
4	—	**Brooktree** San Diego	117.8	83.4	9.5	9/91	semiconductors
5	—	**Cabletron Systems** Rochester, N.H.	115.8	180.5	35.9	2/91	communications
6	—	**Advanced Logic Research** Irvine, Calif.	109.1	228.0	14.7	9/91	computers
7	—	**American Power Conversion** West Kingston, R.I.	106.4	93.6	15.5	12/91	components
8	—	**Read-Rite** Milpitas, Calif.	103.4	177.0	23.1	9/91	components
9	—	**Altera** San Jose	99.4	106.9	17.8	12/91	semiconductors
10	—	**Encore Computer** Fort Lauderdale, Fla.	99.3**	150.0**	NA	12/91	computers
11	—	**Atmel** San Jose	90.5	120.4	10.3	12/91	semiconductors
12	—	**MIPS Computer Systems** Sunnyvale, Calif.	84.5	168.5	-34.7	12/91	computers
13	—	**Digital Microwave** San Jose	81.8	136.0	3.8	3/91	communications
14	—	**Knowledgeware** Atlanta	80.9	124.3	15.3	6/91	software
15	3	**Oracle Systems** Redwood Shores, Calif.	79.4	1,027.9	-12.4	5/91	software
16	—	**Chips and Technologies** San Jose	77.7	225.1	-9.6	6/91	semiconductors
17	6	**Octel Communications** Milpitas, Calif.	74.5	160.3	17.7	6/91	communications
18	8	**Sun Microsystems** Mountain View, Calif.	72.6	3,221.0	190.0	6/91	computers
19	1	**Teradata** Los Angeles	71.8	257.8	-2.4	6/91	computers
20	—	**Adobe Systems** Mountain View, Calif.	70.3	229.7	51.6	11/91	software
21	4	**Komag** Milpitas, Calif.	70.2	279.2	17.2	12/91	peripherals
22	—	**Aldus** Seattle	69.3	167.5	23.8	12/91	software
23	10	**Symbol Technologies** Bohemia, N.Y.	69.0	319.4	22.8	12/91	computer-based systems
24	9	**Silicon Graphics** Mountain View, Calif.	67.7	549.9	32.9	6/91	computers
25	11	**Dell Computer** Austin	66.5	889.9	50.9	1/92	computers
26	—	**Sierra Semiconductor** San Jose	62.0	85.9	13.1	12/91	semiconductors
27	13	**Cadence Design Systems** San Jose	61.5	392.3	-21.7	12/91	software
28	—	**Symantec** Cupertino, Calif.	60.8	116.3	9.4	3/91	software
29	2	**Sequent Computer Systems** Beaverton, Ore.	60.5	213.3	-48.7	12/91	computers
30	20	**Maxtor** San Jose	56.4	871.3	-45.4	3/91	peripherals
31	22	**Microsoft** Redmond, Wash.	56.3	1,843.4	462.7	6/91	software
32	—	**System Software Associates** Chicago	55.9	149.1	16.7	10/91	software
33	41	**Micron Technology** Boise, Idaho	54.2	425.4	5.1	8/91	semiconductors
34	38	**Silicon Valley Group** San Jose	53.2	234.8	1.6	9/91	semi equipment
35	5	**Dallas Semiconductor** Dallas	51.1	103.8	14.7	12/91	semiconductors
36	17	**BMC Software** Sugar Land, Tex.	50.6	139.5	31.4	3/91	software
37	—	**Landmark Graphics** Houston	50.3	89.9	9.8	6/91	computer-based systems
38	18	**Borland International** Scotts Valley, Calif.	50.2	226.8	26.8	3/91	software
39	23	**Vishay Intertechnology** Malvern, Pa.	49.8	442.3	20.9	12/91	components
40	49	**Quantum** Milpitas, Calif.	48.6	877.7	73.9	3/91	peripherals
41	—	**Everex Systems** Fremont, Calif.	46.3	425.1	-48.0	7/91	peripherals, computers
42	54	**Solectron** San Jose	44.6	265.4	9.2	8/91	contract manufacturing
43	—	**Electronic Arts** San Mateo, Calif.	43.7	101.8	9.1	3/91	software
44	—	**VeriFone** Redwood City, Calif.	43.2	187.9	18.7	12/91	computer-based systems
45	—	**Plexus** Neenah, Wisc.	43.0	120.4	3.6	9/91	contract manufacturing
46	15	**Seagate Technology** Scotts Valley, Calif.	42.2	2,677.0	62.8	6/91	peripherals
47	14	**Cypress Semiconductor** San Jose	41.3	286.8	34.2	12/91	semiconductors
48	21	**Novell** Provo, Utah	39.8	640.1	162.5	10/91	software
49	—	**Acuson** Mountain View, Calif.	39.3	336.3	58.5	12/91	medical
50	26	**Compaq Computer** Houston	39.2	3,271.4	130.9	12/91	computers

* Compounded average annual growth rate (1986-1991) **Estimate NA=Not available

100 FASTEST GROWING COMPANIES

Electronic Business

Rank 1991	Rank 1990	Company Location	Five-year sales growth* (%)	Fiscal 1991 sales ($ millions)	Fiscal 1991 profits ($ millions)	Fiscal year ended	Industry segment
51	—	**Autodesk** Sausalito, Calif.	39.2%	$274.0	$57.8	1/92	software
52	33	**Pyramid Technology** Mountain View, Calif.	39.2	227.9	12.0	9/91	computers
53	25	**Concurrent Computer** Tinton Falls, N.J.	38.0	254.9	-66.8	6/91	computers
54	24	**Informix** Menlo Park, Calif.	37.8	179.8	12.2	12/91	software
55	12	**Convex Computer** Richardson, Tex.	37.6	198.1	-6.9	12/91	computers
56	—	**Proteon** Westborough, Mass.	37.3	94.7	6.0	12/91	communications
57	36	**Tandon** Chatsworth, Calif.	35.8	461.4	-48.0	12/91	computers
58	67	**ASK Computer Systems** Mountain View, Calif.	35.2	343.9	2.7	6/91	software
59	16	**Interleaf** Waltham, Mass.	35.2	84.3	-1.3	3/91	software
60	35	**Archive** Costa Mesa, Calif.	34.4	345.6	-49.3	9/91	peripherals
61	51	**Applied Materials** Santa Clara, Calif.	33.7	638.6	26.2	10/91	semi equipment
62	27	**3Com** Santa Clara, Calif.	33.5	398.6	-27.7	5/91	communications
63	—	**Linear Technology** Milpitas, Calif.	33.3	94.2	16.9	6/91	semiconductors
64	19	**FileNet** Costa Mesa, Calif.	33.2	122.5	8.1	12/91	computer-based systems
65	—	**Qume** Milpitas, Calif.	33.1	217.5	-19.6	2/91	peripherals
66	28	**Rexon** Manhattan Beach, Calif.	33.0	183.0	10.8	9/91	peripherals
67	45	**Anthem Electronics** San Jose	32.1	419.6	23.3	12/91	distribution
68	29	**Adaptec** Milpitas, Calif.	32.1	128.9	12.2	3/91	peripherals
69	47	**AST Research** Irvine, Calif.	31.9	688.5	64.7	6/91	computers
70	—	**Goal Systems International** Columbus, Ohio	31.6	127.8	10.2	1/92	software
71	—	**Legent** Vienna, Va.	30.5	203.3	33.9	9/91	software
72	62	**Intel** Santa Clara, Calif.	30.4	4,778.6	818.6	12/91	semiconductors
73	43	**VLSI Technology** San Jose	29.9	413.4	9.9	12/91	semiconductors
74	37	**Stratus Computer** Marlborough, Mass.	29.2	448.6	49.7	12/91	computers
75	39	**LSI Logic** Milpitas, Calif.	29.2	697.8	8.3	12/91	semiconductors
76	55	**Applied Magnetics** Goleta, Calif.	28.9	455.5	-18.3	9/91	components
77	34	**EMC** Hopkinton, Mass.	28.4	232.4	13.0	12/91	peripherals
78	—	**Nellcor** Hayward, Calif.	28.0	158.9	16.3	6/91	medical
79	32	**Integrated Device Technology** Santa Clara, Calif.	28.0	198.6	1.2	3/91	semiconductors
80	60	**Apple Computer** Cupertino, Calif.	27.1	6,308.0	309.8	9/91	computers
81	31	**Western Digital** Irvine, Calif.	26.8	986.2	-134.2	6/91	semiconductors, peripherals
82	—	**Nichols Research** Huntsville, Ala.	26.7	91.5	4.7	8/91	government
83	42	**QMS** Mobile, Ala.	26.3	304.3	18.1	9/91	peripherals
84	70	**Loral** New York	26.2	2,126.8	90.4	3/91	government
85	40	**Applied Biosystems** Foster City, Calif.	25.9	163.9	-2.8	6/91	medical
86	—	**CMS Enhancements** Irvine, Calif.	25.9	130.1	-8.5	6/91	peripherals
87	83	**LAM Research** Fremont, Calif.	25.2	144.0	6.1	6/91	semi process equipment
88	75	**Hutchinson Technology** Hutchinson, Minn.	24.9	143.3	4.5	9/91	components
89	56	**Lotus Development** Cambridge, Mass.	24.0	828.9	43.1	12/91	software
90	76	**Sensormatic Electronics** Deerfield Beach, Fla.	23.9	239.2	24.7	5/91	computer-based systems
91	—	**Boole and Babbage** Sunnyvale, Calif.	23.7	98.6	-11.0	9/91	software
92	—	**Structural Dynamics Research** Milford, Ohio	23.2	146.3	17.9	12/91	software
93	—	**American Software** Atlanta	21.6	101.9	17.5	4/91	software
94	30	**Computer Associates Int'l** Garden City, N.Y.	21.5	1,348.2	159.3	3/91	software
95	78	**Medtronic** Minneapolis	19.9	1,021.4	133.4	4/91	medical
96	58	**Tandem Computers** Cupertino, Calif.	19.8	1,922.2	35.2	9/91	computers
97	48	**Data Switch** Shelton, Conn.	19.6	103.0	-32.8	12/91	components
98	53	**Inmac** Santa Clara, Calif.	19.5	302.8	6.8	7/91	communications
99	74	**Molex** Lisle, Ill.	19.4	708.0	64.6	6/91	components
100	64	**BancTec** Dallas	19.2	183.8	10.7	3/91	computer-based systems

* Compounded average annual growth rate (1986-1991)

Source: ELECTRONIC BUSINESS

100

FASTEST GROWING COMPANIES

Brace for the next wave of hot young companies

The top 14 are new to the list—part of a 38% turnover. Recession felled the old guard while IPOs helped newcomers

By Linda Stallmann and E. B. Baatz

Companies that just missed this year's title

1991 sales ($ millions)

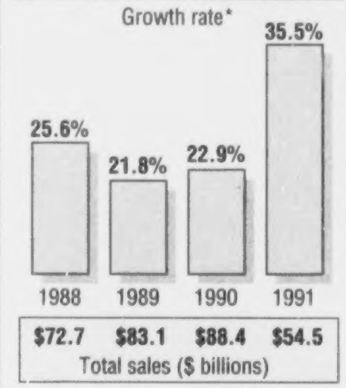
Company	Sales	Company	Sales
Acclaim Entertainment	$122.1	**Micronics Computers**	$133.9
Cisco Systems	183.2	**Novellus Systems**	80.0
Conner Peripherals	1,599.0	**Radius**	118.6
Exabyte	234.1	**Cirrus Logic**	141.8
Executone Info Systems	266.6	**Xilinx**	97.6

Source: ELECTRONIC BUSINESS

COMPANIES must meet several criteria to be eligible for the ELECTRONIC BUSINESS fastest-growing list. Companies are ranked by five-year compounded average annual sales growth and must have more than $1 million of revenue in the base year of 1986 and at least $80 million in 1991. They must be U.S.-based, publicly held, and receive at least half their revenues from electronics. Several that performed well last year failed to meet those criteria and so didn't make our list. Some, however, shape up as strong contenders for next year. ☐

THE 100 fastest-growing companies together grew at a compounded average annual rate of 35.5% during the past five years, more than 10 points faster than the companies that made up last year's list. The faster growth was due to the addition of a multitude of smaller companies to the list (some of which just went public in the past year). Total 1991 revenues of the 100 companies came to only $54.5 billion, nearly $34 billion less than 1990's list. This rise in the number of small companies on the list indicates a significant shift in the demographics of the industry as a whole. ☐

The top 100 at a glance



*Compounded annual rate, five-year average

Source: ELECTRONIC BUSINESS

RAPID revenue growth doesn't ensure profits. In fact, about one-fifth of the 100 companies on this year's list *lost* money in 1991. The best performers (measured by profits as a percentage of sales) were Novell, Microsoft, and BMC Software—all software companies with low overhead costs. Top profit makers as measured by sheer dollars are Intel ($819 million) and Microsoft ($463 million). ☐

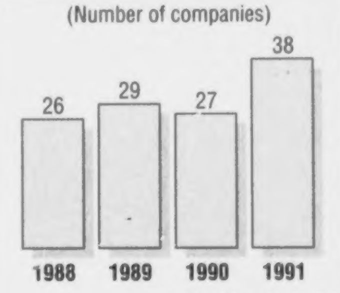
Novell tops this year's list in profits

Company	Profits as % of sales	Profits ($ millions)	Rank
Novell	25.4%	$163	48
Microsoft	25.1	463	31
BMC Software	22.5	31	36
Adobe Systems	22.5	52	20
Autodesk	21.1	58	51
Cabletron Systems	19.9	36	5
Linear Technology	18.0	17	63
Acuson	17.4	59	49
American Software	17.2	18	93
Intel	17.1	819	72

Source: ELECTRONIC BUSINESS

THIRTY-EIGHT new companies joined the fastest-growing list in 1991. The 14 fastest-growing, in fact, are all newcomers, including Zeos International, Cabletron Systems, American Power Conversion, and Encore Computer. At the same time, several billion-dollar-plus companies—including Hewlett-Packard, Motorola, and Unisys—dropped off the list due to slow growth over the past five years. Amdahl, Intergraph, and SCI Systems were also pushed off the fastest-growing list by smaller companies. ☐

New arrivals to the fastest-growing list



Source: ELECTRONIC BUSINESS

The 1991 billion-dollar club

Company	Sales ($ billions)	Growth rate*	Rank
Apple Computer	$6.31	27.1%	80
Intel	4.78	30.4	72
Compaq Computer	3.27	39.2	50
Sun Microsystems	3.22	72.6	18
Seagate Technology	2.68	42.2	46
Loral	2.13	26.2	84
Tandem Computers	1.92	19.8	96
Microsoft	1.84	56.3	31
Computer Associates	1.35	21.5	94
Oracle Systems	1.03	79.4	15
Medtronic	1.02	19.9	95

Drop-outs from the billion-dollar club

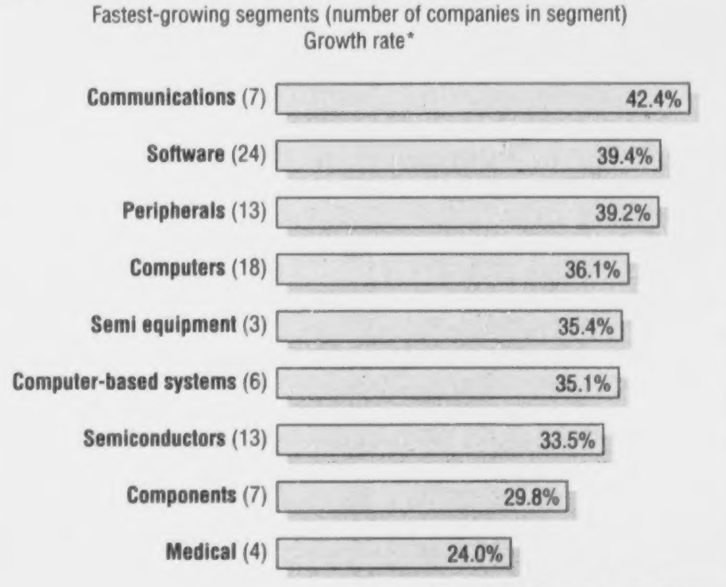
Company	Sales ($ billions)	Growth rate*	Rank
Hewlett-Packard	$14.49	15.3%	—
Motorola	11.34	13.9	—
Unisys	8.70	3.2	—
Amdahl	1.70	12.0	—
Intergraph	1.20	14.6	—
SCI Systems	1.13	19.1	—
Western Digital	0.99	26.8	81

*Compounded annual rate, five-year average

Source: ELECTRONIC BUSINESS

LAST YEAR'S fastest-growing list included 16 electronics companies with more than $1 billion in revenue; only 11 companies hold that distinction this time around. Both Oracle Systems and Medtronic grew their way into the billion-dollar club by just barely clearing the hurdle last year. Western Digital, which still clings to the bottom of the 100 fastest-growing list thanks to fast growth in earlier years, lost revenue in 1991 and so dropped out of the billion-dollar club. ☐

Communications and software pace industry growth



*Compounded annual rate, five-year average

Source: ELECTRONIC BUSINESS

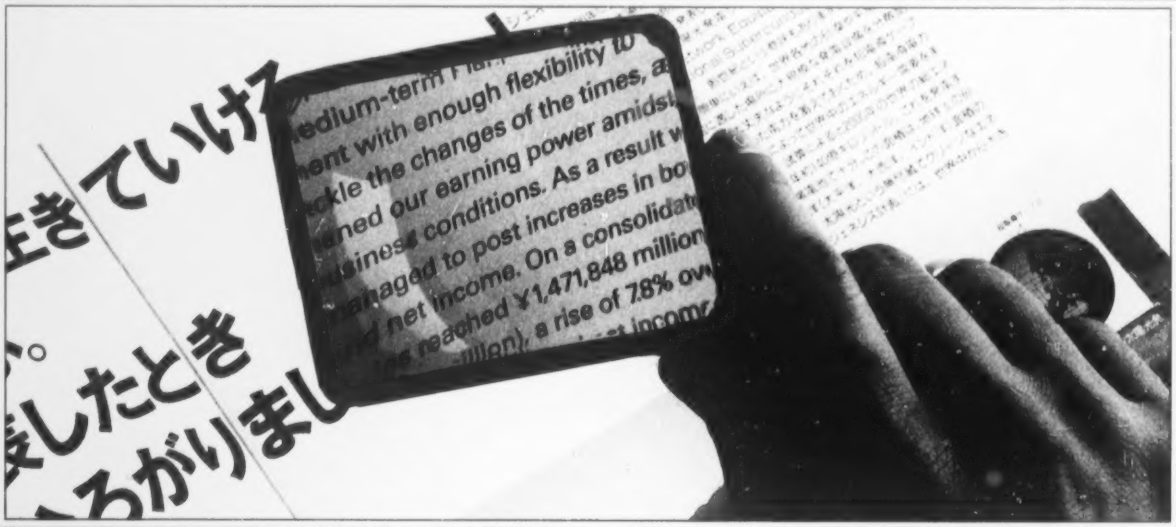
MOST INDUSTRY segments represented by the 100 fastest-growing companies grew much faster between 1986 and 1991 than between 1985 and 1990, but seven companies drove the communications segment to new heights. Synoptics, Cabletron Systems, and Digital Microwave paced the group and brought the communications sector to a five-year growth rate of 42.4%, up from 26.2% last year. Software also soared. With 24 software companies on this year's listing (versus 15 last year), the segment grew at a five-year pace of 39.4%, about the same as last year.

Some industry segments have become extinct in the fastest-growing ranks. Last year, 11 instruments, distribution, and military/government-related companies made the list. Only Anthem Electronics carries the 1991 distribution banner, and government-related business is represented solely by newcomer Nichols Research and old-timer Loral. ☐

What's really inside Japanese annual reports

New data reveals the extent of the lean operating style at Sony, Matsushita, Hitachi, and other leading Japanese electronics companies

By Paula Doe


edium-term
ent with enough flexibility to
ckle the changes of the times, a
ned our earning power amids
iness conditions. As a result
anaged to post increases in bo
net income. On a consolidat
ins reached ¥1,471,848 million
a rise of 7.8% ov
きていけ
したとき
ろがりまし

Part II

Profits at major Japanese electronics companies may have tumbled or evaporated during the past year, but U.S. companies still face a formidable challenge from Sony, Toshiba, Hitachi, Matsushita, and the rest. Recent data from Japan reveal that the world's electronics juggernaut retains a powerful edge over its U.S. rivals in terms of productivity, administrative expenses, and organizational efficiencies.

You can forget the standard rebuttal by U.S. executives that the productivity gap—average sales per employee for the top 10 Japanese companies was $218,900 versus $135,600 for the top 10 U.S. companies in fiscal 1990—is a fluke of subcontracting or Japanese companies' use of subsidiaries. ELECTRONIC BUSINESS's analysis of the 1990 Japanese-language reports on corporate financials, released by Japan's Ministry of Finance (MOF), found that the average Japanese company's value-added per employee was almost twice that of the U.S. median—about $85,000 for the 10 largest Japanese companies versus $43,600 for 383 U.S. companies surveyed by the American Electronics Association. (Value-added per employee is a common measure of productivity that eliminates the effects of subcontracting and subsidiaries.) Comparing a median can be risky, and the AEA companies are much smaller than the Japanese companies, but these statistical fine points only partly explain the disparity.

The $85,000 figure was calculated by subtracting outside purchases of goods and materials from sales. This figure will be a little on the high side, since it still includes outside purchases of such items as utilities and supplies and services used in sales and administration, and doesn't include these costs on overhead, but it provides a reasonable picture of worker output at the parent company. Value-added per employee at the top 10 Japanese electronics companies averages a whopping $168,900, about 39% of total sales.

That's still artificially high, however, since only parent company data is available. Applying the 39% value-added figure to consolidated sales per employee suggests an average output per worker of around $85,000 at top Japanese companies.

"Those are amazing numbers, but quite plausible," notes Maxwell Hall, a director of the Mountain View, Calif., office of the U.S. consulting firm Pittiglio Rabin Todd & McGrath (PRTM). He cites three reasons for the gap: the high automation levels at Japanese electronics companies, the capital intensity of their semiconductor fabrication, and their lower managerial overhead.

Lavish spending on research, production, and test equipment adds to Japanese worker productivity. Total consolidated depreciated fixed assets per employee in 1990 were $76,000 at NEC, $48,900 at Toshiba, and $39,000 at Matsushita. While IBM's fixed assets per employee came in at $72,873 in 1990, three other leading U.S. companies ran only about half that: Motorola ran at $35,981, Hewlett-Packard at $34,793, and Digital Equipment at $31,194. U.S. electronics companies in the AEA survey had an even weaker median investment per worker—$11,500—although there's a broad range based on type of company. Semiconductor companies' $20,560 per worker ran at the high end, while makers of peripherals and electronic production equipment came in at less than $10,000.

THE LOWER LEVELS of administrative staffing in Japan also is striking. Despite the common U.S. view of Japanese companies as huge bureaucracies, NEC, Hitachi, Fujitsu, and others actually have lower selling, general, and administrative (SG&A) costs than their U.S. counterparts. On average, consolidated SG&A, including R&D, came to 26.5% of sales in 1990, according to the MOF. The AEA sets the corresponding figure for smaller U.S. companies at 42%. Larger companies are not far off that mark: IBM spent about 40% of revenue on SG&A R&D in 1990, DEC about 43%, and Hewlett-Packard about 39.8%.

Is the disparity due to a different approach to marketing and advertising? Yes and no. Major Japanese companies spent about 12% of total sales for marketing, versus 18% for U.S. electronics companies, according to the AEA survey. (These figures are for the parent company only and don't include additional marketing by the companies' subsidiaries.) "Marketing and related costs are a lot higher in the U.S.," explains Kevin Jones of McKinsey & Co. in Tokyo. "The whole infrastructure for brand development is less in Japan."

While general marketing spending is less, spending on advertising appears to be similar. Hardware companies in the U.S. spent about 1% of sales on advertising, according to the AEA, although makers of peripherals and office and consumer products spent about 2%. The big Japanese companies spent about 1.4%. Computer makers such as Fujitsu spent 1% and consumer companies such as Sharp spent 2.7%.

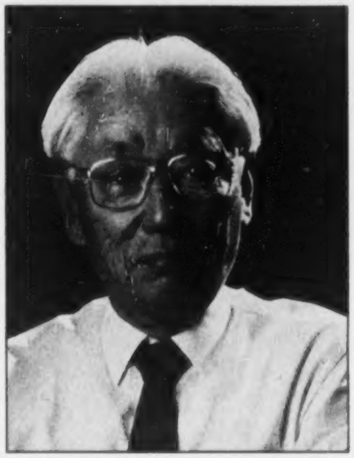
The real difference in SG&A doesn't lie in marketing costs but in the low administrative costs within Japanese electronics companies. Of the 21 cents on average that those companies spent on SG&A in 1990 for each $1 of revenue on an unconsolidated basis, about 12 cents went for sales costs, and less than 10 cents for general administration, including R&D. By comparison, the companies in the AEA survey reported median general administrative costs of 11.4% of revenue, *not* including R&D. Experts say the differences are due to Japanese companies' smaller corporate staffs, lower pay scales, and a longer work week. Japanese manufacturing put in an average of 2,124 hours in 1990, for example, 9% more than in the U.S., according to Japan's Ministry of

Sony's Morita urges higher pay, fewer hours for Japanese workers

THREE MONTHS AGO, Sony Corp. chairman Akio Morita created a stir by arguing that Japanese companies have been exploiting their workers and the community and would have to change. Morita claimed that Japanese companies have consistently made things cheaper than their U.S. or European rivals largely because of "the wide gap between working hours and salary levels between Japan and the U.S. and Europe."

The outspoken Sony founder's essay—"Japanese Style Management in Crisis: Why High Quality, Low Cost Manufacturing is criticized by the U.S. and Europe"—in the influential Japanese monthly *Bungei Shunju* struck a lot of nerves in Japan. Officials of the trade group Keidanren ranted publicly about the call for shorter hours and higher wages for workers just before the start of annual labor negotiations. But the prime minister reportedly telephoned Morita to express his praise for and agreement with Morita's views.

Morita's message apparently got through: The trade group recently approved a 10% reduction in work hours for Japanese employees. ☐



Caroline Parsons/Time Magazine

Will Morita's criticisms of Japan's workplace practices reduce productivity and close the price gap with Japan's competitors? Not dramatically and not soon

Labor. "They just run leaner," points out Daniel Maher, a partner of the Chuo/Coopers & Lybrand Consulting firm in Tokyo. "They use a very decentralized management structure."

How do your costs stack up against Japan's?

Average costs, as percentage of revenue, for 10 major Japanese electronics companies

Cost of goods sold	
Materials	43.9
Labor	8.3
Overhead	10.7
Purchased goods	11.1
Total	74.0
Sales, general & administrative	
Sales	11.6
General & administrative*	9.8
Total	21.4
Operating income	4.6%

*Includes R&D

Source: Japanese Ministry of Finance

It's not just a lean management structure, but efficient management techniques that distinguishes Japanese companies. "The rule of thumb in the U.S. electronics industry is a one-to-one ratio between the average number of direct and indirect laborers," notes Hall of PRTM. "In Japan, there's half an indirect labor person for every direct laborer, due to the efficiency techniques pioneered there." Japanese companies eschew warehousing parts, for example, using the point-of-use inventory technique that eliminates warehouse workers.

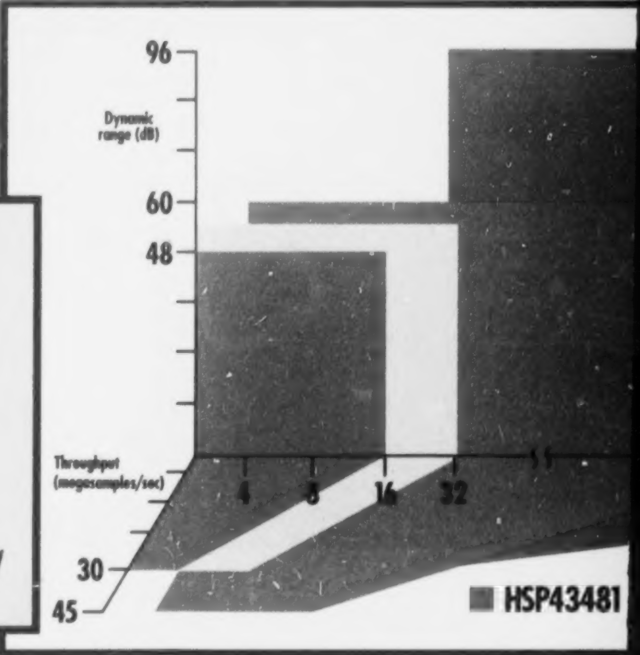
As for the salary gap, "the actual cost per person is lower," adds McKinsey's Jones. The Japanese companies spent an average of only 39 cents in 1990 for sales and administrative salaries and benefits (not counting central R&D) for each $1 spent on manufacturing labor. NEC spent 46 cents while Fujitsu spent only 31 cents. Unfortunately, the AEA survey did not include this type of data.

Note that the MOF numbers aren't absolute. Japanese reporting rules are more flexible than in the U.S., so particular ratios for a company or group of Japanese companies may vary considerably from those of their U.S. counterparts. More significantly, cost allocations are distorted due to the extensive use of subsidiaries and subcontractors. Some administrative costs are hidden as materials costs when components are purchased from subsidiaries or affiliates. Other costs get counted as cost of goods sold due to the decentralized organization of these companies. And some sales costs show up only as the discounted price at which goods are sold to sales subsidiaries or affiliates. Still, the overall trend

CHOICE FIRS

HSP43168 Dual FIR Filter

- World's fastest standard FIR filter at 45 MHz
- Flexible for multiple configurations
- From two 4-tap filters to one 256-tap filter
- Stores 32 filter sets on chip; changes filters on the fly



Nobody gives you more choices in programmable FIR filters than Harris. From the 45 megasamples per second throughput of our HSP43168, to the 512,000-equivalent-tap precision of our HSP43220, Harris has a FIR filter that meets your digital filtering needs.

is too big to be explained by accounting differences. These companies run lean.

ONE REASON is such management practices as just-in-time (JIT) inventory control. The dramatic impact relative to U.S. manufacturers can be seen in the MOF reports: The top Japanese companies report parts and materials inventories turnover in a matter of days, on a consolidated basis, while turnover rates at the smaller companies surveyed by the AEA may be measured in weeks. NEC reports turning over its components inventory every 11 days, Fujitsu every 10 days, Hitachi every 7 days, and Toshiba every 5 days. By contrast, the AEA survey found an average 51-day turnover rate, according to Peter Bearse, an economist and head of Development Strategies Corp. in Gloucester, Mass., who conducted the survey.

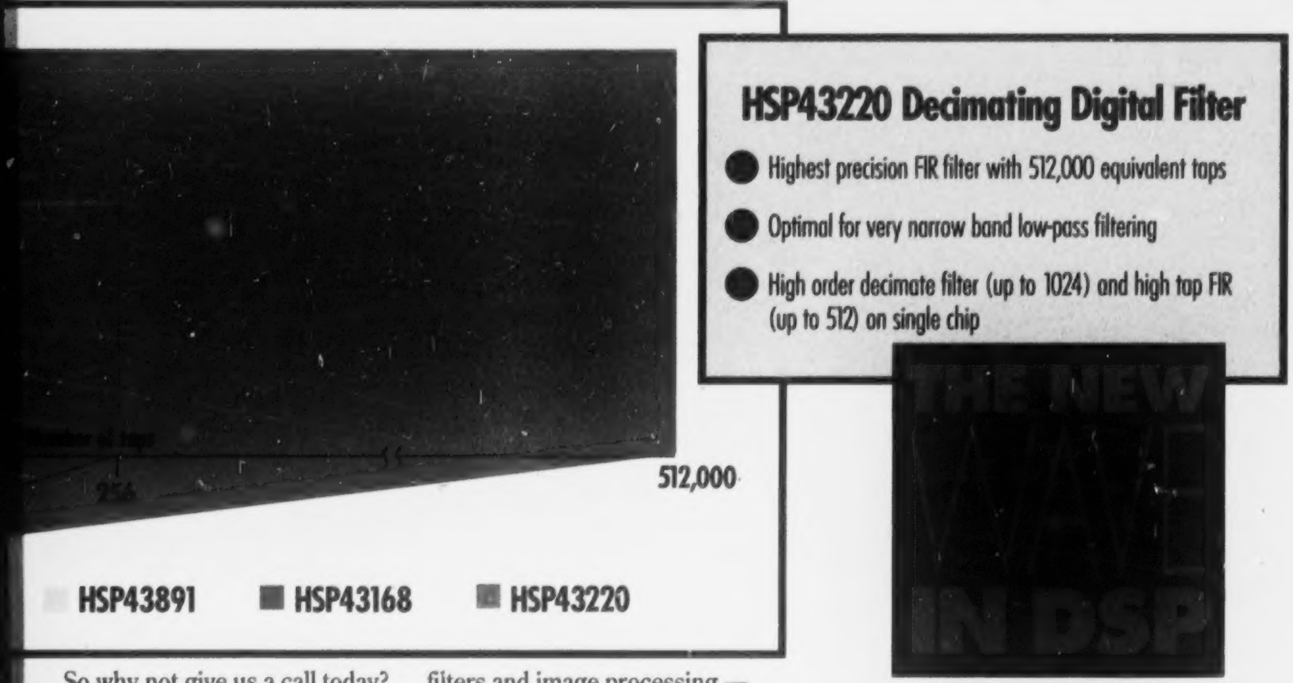
The result of this efficient manufacturing and lean overhead is that the Japanese can make money in consumer electronics in non-recessionary times, despite the influx of assemblers and copycats from Taiwan, Korea, and elsewhere.

Indeed, consumer electronics were more profitable for some companies than the supposedly higher-margin computer and telecommunications market, according to the MOF; margins in all sectors will be down sharply for the current year, however. Sony Corp. managed operating earnings of 8.4% of revenue on its consumer electronics business in fiscal 1990, while Matsushita Electric Industrial Co. made 6.8%. That's more than industry leaders NEC and Fujitsu earned from selling computers, components, and telecommunications gear. NEC earned only 5.8% on its sales, while Fujitsu showed a 6.6% margin. Matsushita also had slightly higher margins on its consumer business than in its own computer and communications business, where it earned 6.5%.

Japanese companies differ from their U.S. counterparts with smaller staffs, lower pay, and a longer work week

The diversified electric equipment suppliers Hitachi and Toshiba made fatter margins in their industrial electronics business. Hitachi achieved margins of only 1.2% in its consumer business, but a healthy 8.6% in computers and components. Toshiba managed a 2.8% margin in the consumer segment, but a 7.9% operating profit in computers and components.

The 1990 reports were the first ones to reflect a new requirement that Japanese companies disclose operating profits by business sector. Responding much as U.S. companies did to the introduction of similar U.S. rules some years ago, most of the major Japanese electronics companies lumped business units together to avoid revealing separate semiconductor and computer profit margins. And few reported earnings or even sales by geographic region as theoretically required. ☐



HSP43220 Decimating Digital Filter

- Highest precision FIR filter with 512,000 equivalent taps
- Optimal for very narrow band low-pass filtering
- High order decimate filter (up to 1024) and high tap FIR (up to 512) on single chip

So why not give us a call today? With our broad line of DSP products — including NCOs, digital filters and image processing — we're the new wave in DSP. Catch it. Call 1-800-4-HARRIS, ext. 1172.

HARRIS
SEMICONDUCTOR

FPGA market booms, but too many vendors could sink profits

Patent fights, price pressures, and the emergence of third-party tools will cull winners from losers

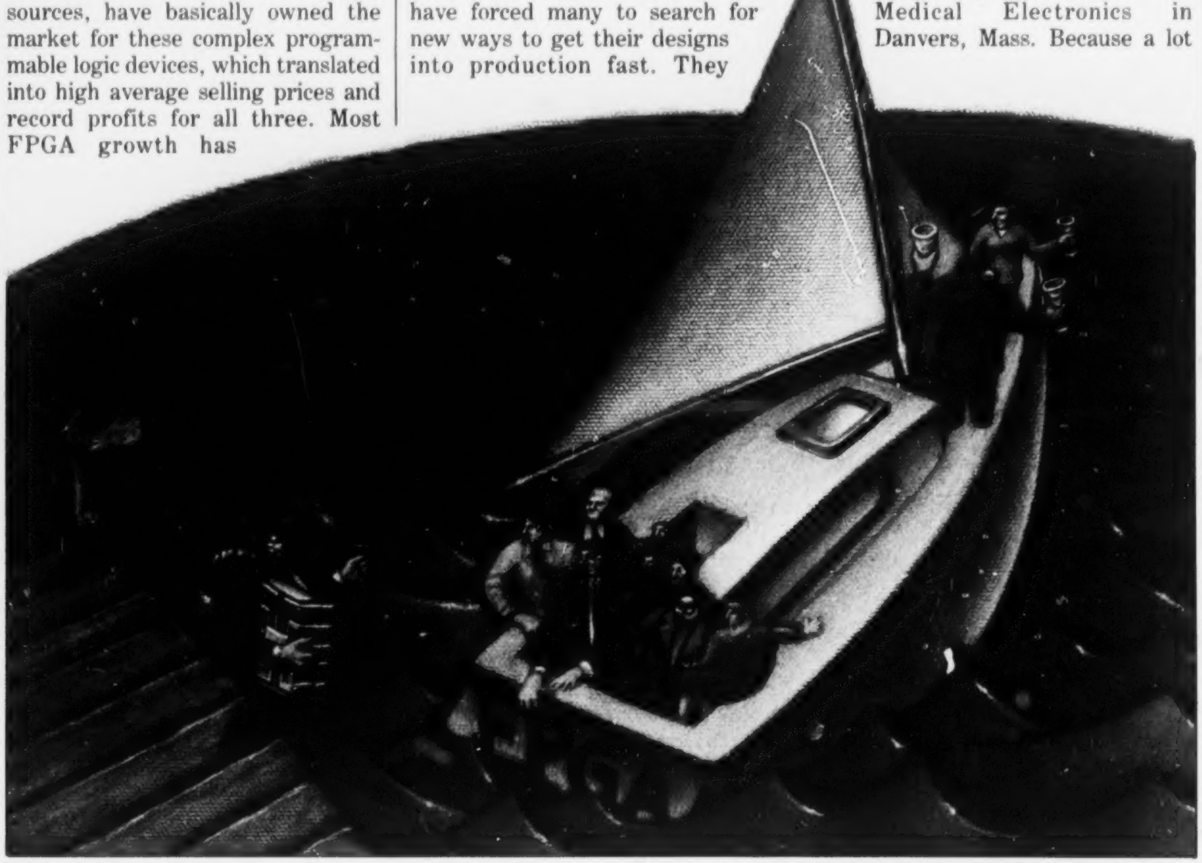
By Hugh G. Willett

As the field-programmable gate array (FPGA) market approaches its next stage of development, a rush of new profit-seeking vendors and the rise of universal design tools could signal the beginning of fierce competition in this so-far money-making market.

For the past few years Actel, Altera, and Xilinx, and their second sources, have basically owned the market for these complex programmable logic devices, which translated into high average selling prices and record profits for all three. Most FPGA growth has come from two quarters: those that integrate many low-end programmable logic devices (PLDs) into fewer FPGAs, and those that use FPGAs for prototyping gate arrays before moving into volume production.

"What we're really selling is time-to-market," says Altera chairman and CEO Rodney Smith. The shrinking of system life cycles and the reduction of production runs have forced many to search for new ways to get their designs into production fast. They worry less about marginal price differences and more about hitting profitable market windows. That emphasis is boosting FPGA sales not just for prototyping, but also for production, claims Smith.

Users agree. "We'd like to use FPGAs for all our designs, but we'll wait for the price to drop," says Larry Madsen, senior hardware engineer at Siemens Medical Electronics in Danvers, Mass. Because a lot



Jere Smith

of medical equipment is sold in low volumes, FPGAs are considered production solutions. In high-volume applications, however, gate arrays are still preferred, he says.

The complex PLD and FPGA market will grow from a still-small $186.7 million in 1991 to roughly $900 million by 1995, according to InStat, a Scottsdale, Calif.-based market research firm. "The FPGA market is just about ready for its next big growth spurt," says InStat analyst Rhondalee Rohleder. Although true gate array replacement accounted for less than 20% of the total FPGA market, many observers think FPGAs will capture an increasing share of that market as FPGA densities increase. That could transform the $3.5 billion gate array market—at least at the low end—into the most important source of new FPGA design wins. Low-cost mask-programmed parts from Xilinx and Altera are already easing the transition to high-volume production wins by lowering costs for users, Rohleder says.

It seems now that everyone wants a slice of the FPGA pie. In the past three years, at least a half dozen start-ups have entered the FPGA arena. The list of newcomers includes QuickLogic, Crosspoint Solutions, Concurrent Logic, Plus Logic, and Lattice Semiconductor. GEC Plessy and Algo-tronics, both from Britain, have stepped up to represent Europe in the FPGA sweepstakes.

"We've found a gap in the market big enough to drive a truck through," says Crosspoint Solutions' Vagit Arat

Who's using FPGAs?

Worldwide CMOS FPGA market demand ($ millions)

	1990 Consumption	1990 % market share	1995 Consumption	1995 % market share	1990-1995 CAGR
EDP	$43	40.0%	$178	32.5%	32.9%
Communication	24	22.5	156	28.5	45.4
Industrial	21	19.0	104	19.0	37.7
Consumer	2	1.5	8	1.5	32.0
Military	18	17.0	102	18.5	41.5
Automotive	0	0.0	0	0.0	NA

Source: In-Stat Inc.

The barriers to entry for newcomers, however, are quite formidable. One significant barrier is the software tools required to design and program FPGAs. Altera, Xilinx, and Actel have sold, at a healthy profit, proprietary design environments that are not compatible with one another nor with the new upstart architectures. Indeed, tool sales, rather than silicon, have been important profit centers for these vendors. Users are not about to invest in new software and training on the promise of unproven technology, claims John East, president and CEO of Actel.

Siemens's Madsen, who uses the Actel parts, says the software issue is critical to the success of new architectures. "We don't want to invest in new design software," he confirms.

A potentially bigger obstacle to entry is the brewing patent battles between competing vendors. In fact, intellectual property has already surfaced as a thorn in the side of Actel. In March 1992, Xilinx filed suit in Federal District Court in California charging Actel with infringement of a broad patent—issued in 1989—which covers circuits with configurable logic elements and configurable interconnects. If the patent is upheld, other FPGA vendors could be targeted, says Bob Hinkley, vice president and general counsel at Xilinx. Actel's East denies infringement and points out that the Xilinx patent is under reissue, which clouds its validity. "I know how hard it was for us to overcome these barriers, and we were only two or three years behind Altera and Xilinx. I think it's going to be very difficult for a new vendor to get in now," East says.

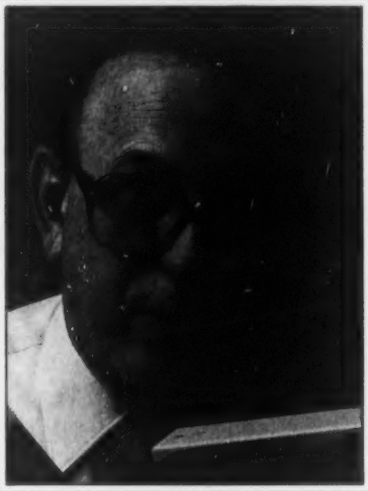
Legal battles aside, both Altera's Smith and Actel's East claim the newer FPGA architectures will either fail or be absorbed by the larger players who can provide access to distribution and the already installed base. That Plus Logic, one of the first to follow the three leaders into the market, was recently acquired by Xilinx is offered as proof that the consolidation has already begun by Smith and East. Not surprisingly, the newcomers disagree. They're confident that the market wants and needs more choices.

The growth of third-party design automation tools from Viewlogic, Cadence, and Mentor has also sparked a mini-revolution from companies such as Data I/O, NeoCAD, and Exemplar, providing PLD- and FPGA-specific tool sets that promise to outperform the proprietary tools, says Vagit Arat, VP of marketing at Crosspoint Solutions in Santa Clara, Calif. "We've found a gap in the market big enough to drive a truck through," he proclaims. "We have produced a design kit that is transparent to the user."

Arat thinks that the biggest opportunities are in the CMOS ASIC market and says designers will want to use the same tools to design FPGAs that they use for gate array development. Crosspoint's fine-grained architecture is more like a gate array than any other FPGA offering. Using the same tools will permit users to avoid the added tool investment and a long learning curve, he claims.

The new architectures offer specific advantages that, while not replacing the existing architectures, can provide specific advantages for certain applications, says Joel Rosenberg, director of marketing at Concurrent Logic in San Jose. Concurrent's chips have more registers than competing architectures, making them better solutions for register-intensive applications for telecommunications and deep-state machines, he says.

As of yet, the new architectures have lived up to their claims, says Jim Christopherson, VP of engineering at Accutonics. It's just a matter of time before universal tool sets become good enough to make an impact, contends InStat's Rohleder. Accurate benchmark tests that will let a designer know just which part is best for the application is also needed. Thus far, speed and density claims have been exaggerated so much that designers must become proficient with architectures before they can compare them.



John Kennard

"We'd like to use FPGAs for all our designs, but we'll wait for the price to drop," says Siemens's Larry Madsen

"By next year, universal tools will be superior to proprietary offerings," contends Larry Morrel, VP of marketing at Data I/O in Redmond, Wash. Ultimately, high-quality universal tool sets will enable a designer to concentrate on logic design and then look for the best performance and price among the devices available, says Morrel, and he predicts that such competition will lower prices, sparking fierce wars within two or three years.

Worldwide CMOS PLD end-market demand

($ millions)

	1990 Consumption	1990 % Market share	1995 Consumption	1995 % Market share	1990-1995 CAGR
Total CMOS PLD					
EDP	$159	51.5%	$339	32.5%	16.3%
Communication	67	21.8	235	28.5	28.5
Industrial	54	17.5	152	19.0	23.0
Consumer	3	1.0	8	1.5	21.7
Military	25	8.2	89	18.5	28.9
Automotive	0	0.0	0	0.0	NA
CMOS EPLD					
EDP	$63	36.8%	$103	28.8%	10.3%
Communication	36	21.0	100	28.0	22.7
Industrial	48	28.1	102	28.5	16.3
Consumer	2	1.0	3	1.1	8.4
Military	22	12.9	50	14.0	17.8
Automotive	0	0.0	0	0.0	NA
CMOS E^{2}PLD					
EDP	$96	70.1%	$236	50.5%	19.7%
Communication	31	22.6	135	28.9	34.2
Industrial	6	4.4	50	10.7	52.8
Consumer	1	0.7	6	1.2	43.1
Military	3	2.2	39	8.3	67.0
Automotive	0	0.0	0	0.0	NA

Source: In-Stat Inc.

Price is definitely an important factor in the FPGA market. Actel recently reduced its prices down as much as 28% on its first- and second-generation parts. Xilinx has also lowered its prices, to less than $5 on some FPGAs, breaking the price barrier that existed when FPGAs were more than three times the cost of gate arrays.

With only a 3X differential with gate arrays, time-to-market advantages make FPGAs a viable option for production volumes, says Bob Zielke, director of marketing at Xilinx. "It has already become a manufacturing race instead of a design-win race," he says. "Most designers have chosen their architecture, and they're looking to use FPGAs instead of gate arrays." Crosspoint is not ignoring the cost question, Arat says. His company has signed several large, but as yet unnamed, Japanese chip makers to build its devices, ensuring that Crosspoint can compete on price with both gate arrays and other FPGA suppliers.

Third-party tool vendors agree that FPGAs will become less expensive as competition increases and transparent design is made possible. "Once the gate array customer could design a device independently, new suppliers came into the market, and prices fell," says Robert Anastasi, VP of marketing at NeoCAD in Colorado Springs, Colo.

Prices may drop, but the FPGA market will be better off in the long run, says Ewald Detjens, president of Exemplar Logic in Berkeley, Calif., which focuses on logic synthesis and sells its software to both proprietary FPGA vendors and the commercial market. Third-party suppliers specializing in particular niches can provide superior tools, he says. When better tools are available, performance and integration will increase, more gate array designs will be put into FPGAs, and the overall market for all the competing architectures will expand. ☐

Notebook PC makers struggle to survive at "sub-survival" prices

Faced with dozens of competitors and fast-moving technology, vendors seek new product designs that won't break the R&D bank

By Rick Whiting

You can't buy notebook PCs from gumball machines. Not yet, anyway.

Notebook PCs began 1991 as specialty items and finished the year as commodities. As 150 or more vendors flooded the world market with nearly 2.3 million notebooks in 1991, prices eroded by 30%, 40%, or more. The price wars have only become hotter in the first half of 1992, and for notebook vendors the big challenge is differentiating their products enough to make any profit at all.

"And differentiation is hard to come by in this market," says Nassir Ahmed, notebook products marketing director at Texas Instruments Inc.'s peripheral products division in Temple, Tex.

Grant Johnson, product marketing director with Toshiba America Information Systems Inc.: The rapid pace of technology in the notebook market "can kill a small company"

Despite the inherent limits posed by notebooks' size, manufacturers are finding a variety of ways to make their products stand out in the crowd. Some are focusing on technological features—everything from data and fax modems to improved display screens to longer battery life. Other vendors are concentrating on service, distribution, and similar intangibles.

Worldwide sales of notebook PCs climbed from about $2.8 billion in 1990—the first year that notebooks really hit the market—to some $7.4 billion last year, according to InfoCorp in Santa Clara, Calif. And this year the market research firm expects vendors to sell some 3.4 million notebooks valued at $11.2 billion—exceeding sales of all other portable computers combined.

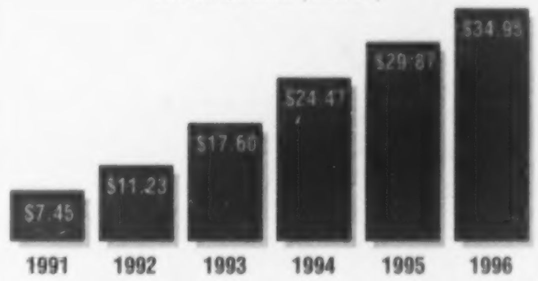
With this growth has come turmoil, however. Average selling prices for 286-based notebooks plunged 46% between the first quarter and the end of 1991, while prices for 386SX-based notebooks fell 35%, according to Sandra Gant, microsystems research vice president at InfoCorp. Notebooks using Intel Corp.'s newer 386SL microprocessor already have been cut to "survival" prices, says Michael A. Aymar, general manager of Intel's entry-level products group in Santa Clara, while notebooks with the SX chip are selling at "sub-survival" prices.

"If one vendor is slow to respond to changes in market pricing, we'll see a drop-off in demand," says Bruce Grant, technical services vice president with MicroAge Computer Centers Inc. in Tempe, Ariz., which resells most major brands of notebooks through value-added resellers and franchise dealers and directly to users. While top-of-the line notebooks carry price tags of $7,000 or more, most run in the $2,000 to $3,000 price range and low-end clones are selling for under $1,000.

The cutthroat competition has taken its toll on already-tight profit margins; one executive, who asks not to be identified, calls a 3% profit margin on a notebook PC "respectable." The strategy at many manufacturers is to keep prices low in order to quickly ramp up sales, rather than earning big margins on each notebook. "Volume is the key to making any money right now," says Sharon Colman, PC products manager at Hyundai Electronics America in San Jose.

The current goal for some vendors is not so much to make money off their products but to build and hold a user base, says Kevin Kilroy, marketing director for Samsung Electronics of America. Some makers of low-priced clones may be selling notebooks below cost in a desperate attempt to gain market share, suspects Grant Johnson, product marketing director with Toshiba America Information Systems Inc. in Irvine, Calif. "Once you get past the top 10 vendors, it's hard to imagine companies surviving by selling [just] hundreds of units per month," he says.

As notebooks shrink, the market grows



Source: InfoCorp

The notebook PC market is relatively fragmented: By most counts, only Toshiba and Compaq Computer Corp. hold market shares in the double-digit range. Apple Computer Inc. is rapidly catching up with its PowerBook notebooks, introduced last fall. Other major players in the market include AST Research Inc., Texas Instruments, Tandy Corp.'s Grid Systems subsidiary, Dell Computer Corp., NEC, Zenith Data Systems, NCR Corp., and Sharp Electronics Corp.

Adding to the market glut are a slew of Taiwanese manufacturers selling low-priced notebook PCs based on a design developed last year by a government-led consortium of 46 companies. Sold under their own label or through OEMs, most of the Taiwan-made clones have few value-added features and, in some cases, says one observer, are of questionable quality. "And they can't keep pace with the technology," says Mike O'Dell, product development vice president at Dell, who estimates that Taiwan clones may lag U.S.- and Japanese-made notebooks by six to eight months.

Still, most observers do not expect an industry shakeout so much as a constant churning of smaller vendors dropping in and out of the market. Bruce Stephen, director of PC hardware research at International Data Corp. (IDC) in Framingham, Mass., says he discovers more notebook hawkers every week. One vendor in San Diego, he says, resells Taiwan clones and is all of five employees conducting sales and support by phone.

How can notebook PC manufacturers distinguish themselves from the rest of the pack? They must make their products as small and as light as possible with easy-to-use keyboards, high-resolution display screens, communications capabilities, large disk capacity, and batteries that last for hours—all at highly competitive prices. Vendors, in short, must design and build Mercedes-Benz sports cars and sell them at Yugo prices. "The trick is doing all this at the right price," Hyundai's Colman says of the balancing act.

Low-quality LCD screens have been the Achilles' heel of the notebook computer

Staying on the leading edge of technology is tough. "That can kill a small company," says Toshiba's Johnson. "Vendors have a narrow window on innovative technologies—they may have a good product at a good price, but in six months it's outdated." While most notebooks now use the 386SX chip, for example, that technology is becoming obseleteas more products based on the 386SL microprocessor hit the market. Specifically designed for notebooks, the 386SL is more tightly integrated to take up less space and offers a "sleep mode" to extend battery life. IDC's Stephen expects that most notebooks shipped will use the SL by year's end.

Speeding that transition is the SL's steadily decreasing price, which has fallen from $176 per chip in 1000-unit lots for the 20-megahertz version in October 1990 to $101 in the first quarter of this year. The newer 25-MHz version is priced at $122, cut from $178 in March.

A few notebooks using the 486DX chip, such as the Slimnote from Taiwan-based Twinhead Corp., are already on the market. But one competitor suggests that given the chip's higher cost, manufacturers that build notebooks with the 486 are seeking publicity more than sales. An SL version of the 486 chip is due by the end of this year.

The current 5-volt version of the 386SL chip will be replaced by a power-stingy 3.3-volt version by mid-year, says Intel's Aymar. Advanced Micro Devices Inc. began marketing its own 3.3-volt 386SL "work-alike" chip last October.

The downside of this improvement is that makers of ASICs and controllers for notebooks must redesign their components for a 3.3-volt world. And since the transition will not happen overnight, manufacturers such as Cirrus Logic Inc. are engineering products for mixed-voltage systems.

Longer battery life and better display screens are the twin holy grails for notebook manufacturers looking to stand out. Battery life ranges from one and one-half hours to four hours or more, depending on the computer's features and the battery technology (alkaline, nickel-cadmium, nickel-metal hydride, etc.).

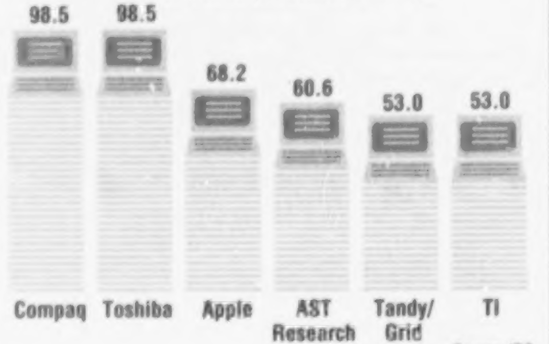
Most notebooks today offer power management features to save juice, such as powering themselves down when the computer is on but not in use. Sharp is taking that idea a step further by designing notebooks with adjustable power consumption.

Low-quality LCD (liquid crystal display) screens have been the notebook's Achilles heel, but the improved LCDs used in most notebooks today are fueling the market's growth. Notebooks with color displays are just now hitting the market and vendors expect growing demand for color as more users add Microsoft Corp.'s Windows and other graphics-intensive software to their machines.

Some vendors are building notebooks with active matrix LCD screens, which offer better resolution than passive matrix screens or older technologies. Sharp's new PC-6881 notebook with a color active matrix LCD, for example, created a splash at the Lap & Palmtop trade show in New York in March. The downside is that color active matrix LCDs cost more ($1,250 to $1,500 or more, compared with about $750 for a color passive matrix LCD), and they are trickier to manufacture: Last month, for example, Epson America Inc. backed off a plan to market the NB-SL/25C color notebook, citing "quality issues" surrounding the computer's metal-insulated-metal active matrix LCD.

Compaq, Toshiba lead U.S. market

1991 U.S. sales (thousands of units)



Source: IDC

Graphics applications for notebooks are also boosting demand for more disk capacity, says MicroAge's Grant. He sees most manufacturers abandoning 40-megabyte disk drives in favor of drives with 70- and 80-Mbyte capacities to meet demand.

Because users buy notebooks to keep in touch with the home office as much as to do work on the road, data modems, fax modems, and other communications capabilities are fast becoming standard requirements. General Electric Co.'s international power systems operation in Schenectady, N.Y., which builds and maintains power plants worldwide, leases more than 300 Compaq notebooks for its field engineering and service staff. The computers' fax and electronic mail capabilities, which allow the troubleshooters to communicate with GE's factories and engineering, sales, and customer service departments, were a major factor in GE's brand choice, says decision support manager John Conroy.

Another differentiating feature is user configurability. Wyse Technology, for example, offers what it calls "personality modules" for its DecisionMate notebooks—cigarette package-size modems, serial ports, mouse pads, and other options that plug into the computer. Librex Computer Systems Inc., a San Jose-based subsidiary of Nippon Steel Co., trumpets its T386SX as "the ultimate configurable notebook" to which users can add 20-, 40-, and 80-Mbyte disk drives, memory cards or modems, "memory modules" of RAM, and other goodies. "But we know these are fleeting advantages," says Martin W. Brauns, Librex's marketing general manager.

To give their notebook computers flexibility, manufacturers are rapidly adopting the PCMCIA (PC Memory Card International Association) interface standard. Originally created to specify how credit-card-size memory cards plug into and work with portable computers, the PCMCIA specifications are now being used by notebook designers to provide connection slots for fax modems, add-in memory modules, and optional input/output devices. They are filling much the same role as the AT-bus slot in desktop PCs.

All this is creating a demand for components, subsystems, and other products that are small, tightly integrated, and consume little power, says Jim Chapman, marketing vice president at Cyrix Corp. in Richardson, Tex., which recently began producing math co-processor chips for notebook computers. Rockwell International Corp. has introduced an internal modem for notebooks that combines data, fax, and voice capabilities. And in February of this year, Intel and disk-drive maker Conner Peripherals Inc. teamed up to develop proprietary flash memory-based solid-state storage devices for notebook and handheld computers.

Beyond technology and price, vendors can leverage service and other extras to stand out from the pack. Wyse Technology's "Notebook Express" service program includes Federal Express pick-up and delivery and a 48-hour turnaround. Hyundai, meanwhile, has been offering a lifetime warranty on its notebooks on a trial basis. And for the environmentally aware, Compaq has started a battery-recycling program.

Given their thin profit margins, few vendors find direct sales to be a viable distribution option; distribution presents vendors with both a challenge and an opportunity to distinguish themselves from the crowd. Notebooks are a natural for the direct-mail sales strategies employed by Dell, Zeos, and Micro Express. Dell, based in Austin, uses a Pacific Rim contract manufacturer to assemble basic notebook computers, then configures each one in its Austin plant according to customer order.

More and more vendors are supplementing their standard dealer-chain sales by moving products through mass merchandise channels—computer superstores such as Dallas-based Comp USA, for example, and office supply chains such as Staples and BizMart.

Vendors are also hunting for value-added resellers who bundle notebooks with application software and sell to such niche customers as insurance claims adjusters and real estate agents.

And then there are always gumball machines . . . ☐

NOTE

ONLY THE FOLLOWING PAGES OF THIS

PUBLICATION HAVE BEEN FILMED

Cov. 1, Pgs: 2, 3, 7, 8,
12, 29, 30, 34-38, 40, 42,
49, 50, 73-76, 103, 104,
106, 108, 110, 112, 114,
131-134, 140, 141, 145,
146, 148, 150, 153

Take the black magic out of software development
PAGE 34

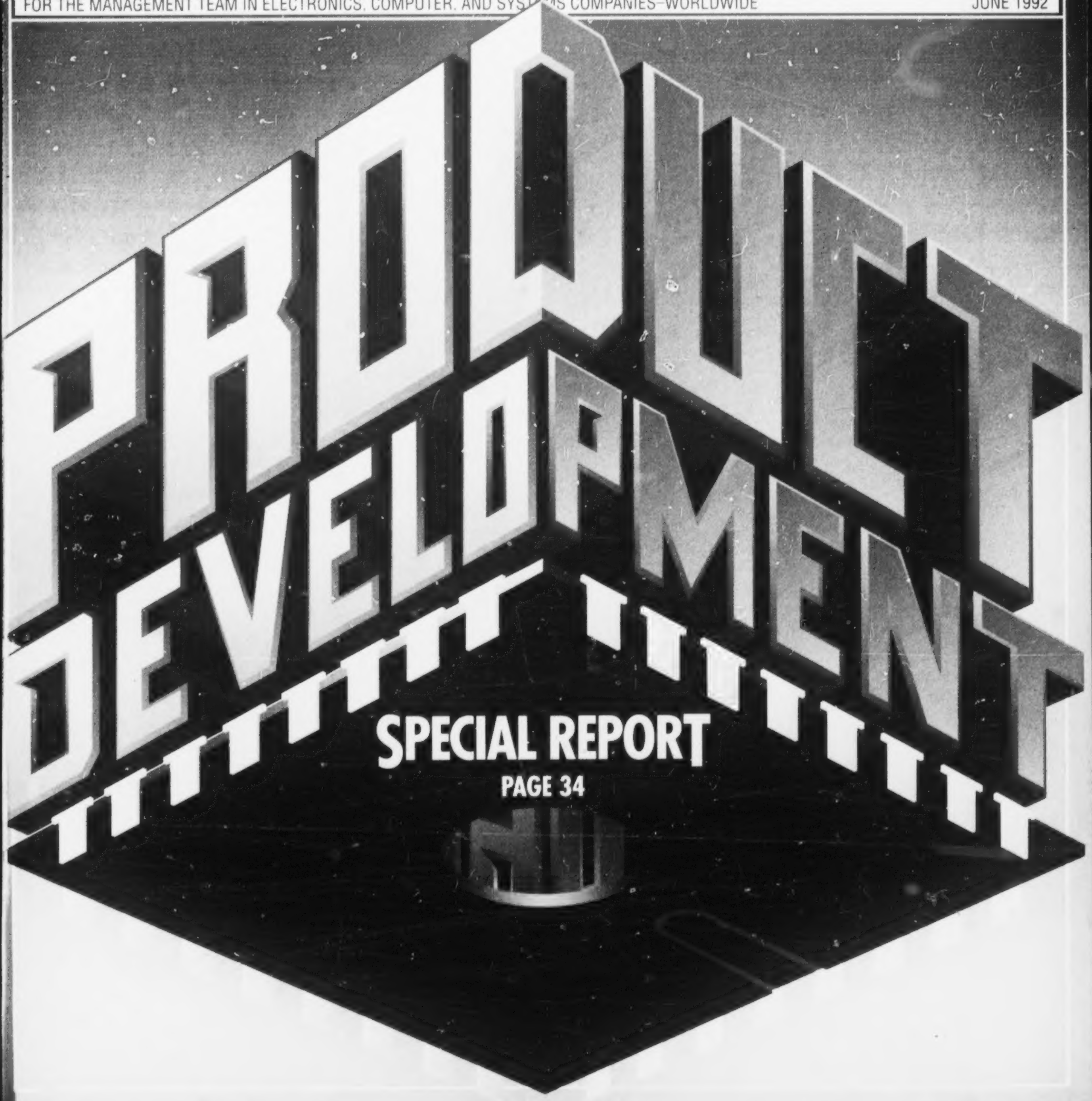
How to win the hearts (and cash) of fickle VCs
PAGE 96

Mentor Graphics' recovery: Lessons from the fall
PAGE 84

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE
JUNE 1992



SPECIAL REPORT

PAGE 34

Electronic Business

VOLUME 18, NUMBER 9

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

JUNE 1992

PROD
DEVELO

COVER STORY

PRODUCT DEVELOPMENT & MANUFACTURING

34 Take the black magic out of software development

It doesn't matter whether you consider software development to be an art or a science. What *does* matter is that you recognize the need for a structured process to help you do it better, do it on time, and do it on budget. New planning tools help you spend more time in the planning process and less time debugging

Cover illustration by Gregg Dinderman

UPFRONT

Business Trends

7 High expectations foil many U.S./Asian joint ventures; Profits picking up at two GaAs leaders; Consortium offers entry to Eastern Europe telecom; Drive makers move to grab VARs' business; Another boom year for electronics IPOs; CFI program promises tools next year

PAGE 7 Companies target objectives

Companies to Watch

25 Aptix makes field-programmable circuit boards for prototype design; Printron prints circuits without pollution; Fourth State Technology keeps tabs on wafer tabs

PAGE 25 Amr Mohsen, founder, chairman, and chief executive officer of Aptix Inc.

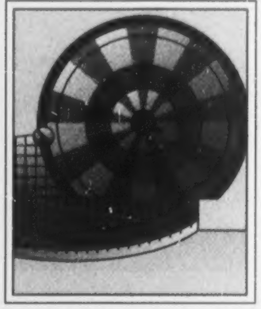
Business Barometer

29 Computers and office equipment
An upbeat first quarter suggests '92 will be better than expected

29 Communication equipment
Surging orders and big backlogs promise 7% growth this year

30 Leading Indicator
Look for slow but steady rise as the economy limps toward recovery

PAGE 96 "It's easy to see a new product replacing an old one . . ." says Gordon Bell



PAGE 140 How semiconductor manufacturing and inspection equipment work

PAGE 145 Electronification keeps demand up

FEATURES

PRODUCT DEVELOPMENT & MANUFACTURING

49 **How does your software operation stack up? (Probably lousy)**
A new process could help you smooth out those software development lumps

53 **Hewlett-Packard's software initiative from the top**
No longer just a hardware company, HP makes software a "core competency"

65 **Here's the truth about Japan's software factories**
Scarce talent hasn't stopped Japan from creating more bug-free software than U.S.

73 **39% of companies use a formal product development protocol**
Almost as many companies don't, however, and they have no plans to do so soon

80 **Don't forget materials in joint product development**
Everyone wins when the right partner is brought into a clearly defined process

BUSINESS STRATEGY

84 **Mentor Graphics recovers from its mighty fall**
Management nightmares at the EDA leader offer lessons in how to stay on top of your fast-moving markets

FINANCE & ECONOMICS

96 **How to win the hearts (and cash) of fickle VCs**
Two start-up veterans urge entrepreneurs to take charge

103 **Venture capital directory**
Our annual listing of who they are, where they are, and what they fund

INTERNATIONAL

123 **PacRim offers second chance for portable-phone makers**
Poor marketing in Britain all but killed the idea, but a new crop of vendors tries again

MARKETS

131 **U.S. equipment vendors leverage IC know-how into LCDs**
Sharp, Toshiba, and other companies seek help in improving their display yields

140 **Domestic equipment makers gained market share in '91**
Sematech is credited with helping U.S. vendors recapture Japanese business

145 **Low-density MCU market is robust but less profitable**
Sweeping electronification keeps demand for 4-bit and 8-bit devices soaring

DEPARTMENTS

My View *By Frank Burge, publisher*

153 Customer Delight. TQL and TQC

Company Index

156 Companies covered in this issue

Advertiser Index

157 Advertisers covered in this issue

Viewpoint *By John Russell, editor*

160 386/486 chip wars tell us the time for change is now

BUSINESS STRATEGIES

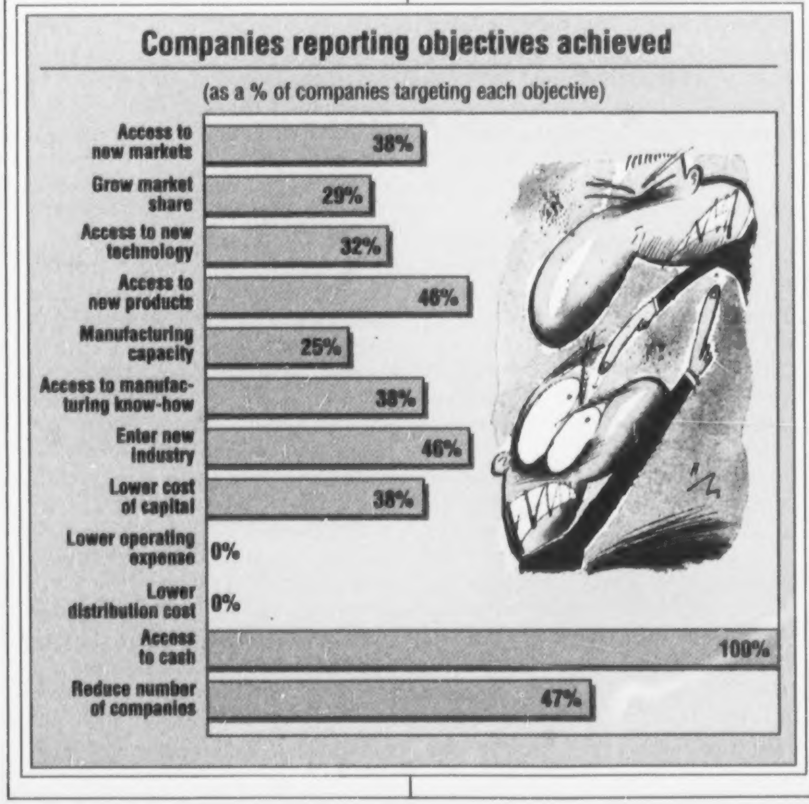
High expectations foil many U.S./Asian joint ventures

MORE THAN HALF of all joint ventures and acquisitions between U.S. and Asian companies result in unfavorable profitability, poor technological exchange, and unimproved market access, according to a survey released by The Rubicon Group International.

In fact, fewer than 5% of the 110 ventures surveyed involving U.S., Japanese, Taiwanese, Singaporean, and Hong Kong companies achieved all of their objectives. Access to new markets was the most common goal, followed by growth in market share and better access to new technologies, new products, distribution channels, and management talent.

Technology companies made up more than half of those surveyed, and there were stark differences in the success of manufacturing-driven ventures and those dependent on technology transfer, says Mark Feldman, managing director of the Orinda, Calif.-based Rubicon Group. "Commodity-oriented deals tended to do better than those that focused on R&D," Feldman says. "Things take longer to get started in R&D deals; the project gets unfocused, and people leave."

Straight manufacturing ventures get started faster and, therefore, tend to be more successful, he says. Significantly more U.S./China ventures reported more favorable results than U.S./Japan deals because of the Japanese emphasis on acquiring new technology.


Companies reporting objectives achieved

(as a % of companies targeting each objective)

Technology transfer is at the heart of most failed joint ventures, confirms Harry Sello, a Menlo Park, Calif.-based technology licensing consultant. The most common problem is the inability to manufacture an unproven technology by the partner who has purchased it in hopes of putting it into volume production. Both sides tend to point fingers at each other. "One side says, 'Your engineers weren't good enough to receive the technology,' and the other side says, 'Your teachers weren't good enough to show us how,' " says Sello. "It's often just a communication problem."

Though language barriers were not a significant factor in success or failure, personnel problems were a big factor, the study shows. Retaining key people was listed as a significant factor in acquisitions.

"In one case we found that a design engineer from the Asian company was paid 50% less than his counterpart in the U.S.," Feldman notes. "That led to a lot of friction."

Turnover at the U.S. companies caused delays in the progress of the deals and added to the difficulty in maintaining communication.

Hidden problems associated with achieving economies of scale through the consolidation of operations and distribution included processing terminations, lost time, lost relationships, and lost knowledge.

—Hugh Willett in San Jose

PROFESSION

How engineering students rate future employers

IT'S A RECESSION and jobs are scarce, so where engineering students get the gall to rate future employers is a mystery. Still, with a nudge from *Graduate Engineer* magazine and the recruitment advertising firm Deutsch, Shea, and Evans, 1,671 engineering students from 275 colleges recently rated the nation's top employers.

Here's how the companies fared:

- Electronics engineers rated Motorola, IBM, AT&T, Intel, and Hewlett-Packard as their top five choices. Motorola was picked by 31% of the students, lifting the company from the number-four spot in 1990 to first place this year.

- Computer science engineers overwhelming rated IBM (50%) and AT&T (34%) as their top two choices, unchanged from two years ago. Motorola, Digital, and Intel round out the top five choices. Microsoft came in sixth with only 12% choosing CEO Bill Gates for a boss.
- Students in all engineering disciplines combined rated IBM tops; 20% indicated a preference for Big Blue. Boeing, AT&T, General Electric, and Motorola were picked by another 15% to 11% of the students.

The students say they form their impressions about companies primarily from articles they read. Direct experience with a company's product or service also figures high in the students' feelings. So good press and good products, apparently, go a long way toward getting good engineers.

—E. B.Baatz

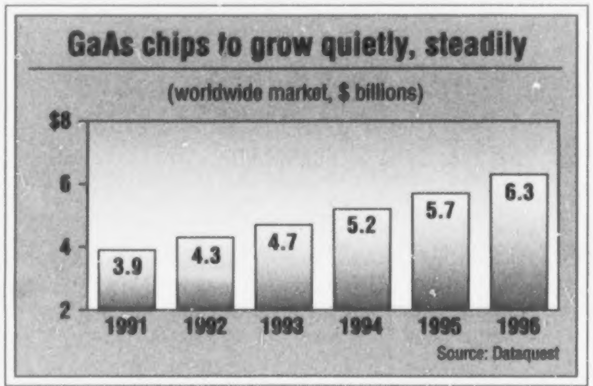
SEMICONDUCTOR MARKETS

Profits picking up at two GaAs leaders

TRACKING THE gallium arsenide (GaAs) IC market isn't all that difficult. Just two companies—Vitesse Semiconductor Corp. and TriQuint Semiconductor Inc.—account for virtually the entire U.S. merchant GaAs chip marketplace.

Recently, both companies improved their sales and profitability, suggesting that GaAs technology—known as much for its high cost as for its high speed—is about to carve out a secure, if small, piece of the semiconductor pie.

The increased sales activity of Vitesse and TriQuint will drive the U.S. GaAs IC market to $83 million this year, or 35% greater than 1991's $61.7 million, predicts Will Strauss, president of research firm Forward Concepts. Vitesse will fuel most of the growth, he says, because it produces digital GaAs components exclusively; about 60% of TriQuint's business comes from analog products, an area that is growing slower than the digital sector. A third GaAs supplier, Anadigics, produces only analog parts and has revenue of less than $2 million.


GaAs chips to grow quietly, steadily

(worldwide market, $ billions)

Source: Dataquest

For its second fiscal quarter, ended Mar. 30, 1992, Vitesse reported revenue of $9.6 million and net income of $851,000—both record levels for the company. Revenue for the first six months of fiscal 1992 totalled $17.7 million, an increase of 71% over 1991's first half.

TriQuint, a private company, won't release its financials but was profitable in both the fourth quarter of calendar 1991 and the first quarter of this year, according to CFO Spencer Brown. Profitability occurred well ahead of the company's timetable following its merger with GaAs vendors GigaBit Logic and Gazelle Microcircuits a year ago.

TriQuint's profitability resulted from a combination of cost-cutting measures and revenue growth, Brown says. Following the merger, the company shed some excess manufacturing and cut its staff to fewer than 200 people. "Sales are now above what they were [in aggregate] prior to the merger," he says. Brown declines to comment on rumors that venture-backed TriQuint might go public this year, but notes such a move is generally the long-term goal of venture capitalists.

Although some observers speculate that captive GaAs manufacturers might eventually toss their hats into the merchant ring, Strauss downplays the possibility. U.S. companies such as Texas Instruments, AT&T, Hughes, Motorola, Rockwell, and McDonnell Douglas all have internal GaAs programs that are tied largely to military contracts. Government-funded programs of this type can tolerate much greater production inefficiencies than are feasible in the merchant marketplace, which makes it tough for the captive players to compete with Vitesse and TriQuint, Strauss says.

—Dwight B. Davis

INTERNATIONAL

Opportunities for U.S. companies in Indonesia

SMALL and midsize U.S. companies that haven't yet established a Far Eastern manufacturing base should now consider a partner in Indonesia, says a Stamford, Conn., strategic matchmaker. Here's why.

First, a recent decision by the Indonesian government to drop restrictive regulations on repatriation of profits will make it practical to keep what you earn. Another reason is a new pact protecting U.S. intellectual property rights.

But the big lure is new business. Demand for electronic components in Indonesia will reach $2.4 billion by 1994, according to the Elsevier Advanced Technology research firm in Oxford, U.K., when sales of consumer electronics products there will reach $398 million and demand for electronic data-processing equipment will hit $350 million.

The country's burgeoning population, now at 180 million, is expected to boost demand for everything from electronic toys to semiconductors over the next decade. Most electronics products are imported from Japan and other Southeast Asian countries as finished goods and subject to high tariffs and import duties. The added cost puts the products out of the

FINANCE

'92 to be another boom year for electronics IPOs

EXPECT 1992 to be another good year for young electronics companies to reap cash and fame in the hot IPO marketplace, although not a repeat of last year's frenzy. Indeed, 53 companies (13 in electronics) went public during the first quarter of '92, up from 12 during the first quarter of '91. Reasonable valuations and a bullish stock market helped 38 computer, software, and communications companies make their initial public offering (IPO) last year.

Oddly, the IPO boom that led 116 companies into the public arena in 1991 has some people worrying. The last time the IPO market soared this high—in 1983, when 121 companies went public—a bust followed with only 53 IPOs in '84 and 47 in '85. No doubt this bubble will eventually burst too, but several indicators suggest 1992 will be a good year for IPOs.

First, the rocky real estate market has created plenty of investment money, and the stock market continues to perform well. Another indicator is how well last year's IPOs performed in the after market—investors seem to think there are more good deals available. Moreover, the electronics industry recession seems to be ending. Semiconductor orders are up and profits are improving.

Altogether, the number of IPOs jumped 176% last year. Biotech start-ups got a big boost, up to 25 from two in the previous year, which shifted electronics' dominance. Electronics/software IPOs accounted for only 32% of total offerings, compared with 50% in 1990 and an average of 43% over the past five years.

Of the 38 electronics IPOs last year, 17 were software or service companies. The voice and data communications industry was represented by another 10 companies and only 3 computer hardware and systems companies went public in 1991.

Top 10 electronics IPOs in 1991

(% change in stock price from date of IPO to Dec. 31, 1991)

Company	Business	IPO date	Price change
Chipcom	Datacom equipment	5/1/91	158%
Quarterdeck Office Systems	Software integrator	6/1/91	133
Broderbund Software	PC software	11/1/91	109
Wellfleet Communications	LAN equipment	7/1/91	109
Xyplex	Communication servers	4/1/91	91
Artisoft	LAN equipment	9/1/91	88
Zilog	Microprocessors	2/1/91	84
Fischer Imaging	X-ray equipment	8/1/91	76
Technology Solutions	Systems integrator	9/1/91	72
Progress Software	Applications software	7/1/91	64

Source: Venture Economics

Chipcom, a data communications equipment maker in Southborough, Mass., performed the best as its initial stock price surged 158% from its IPO on May 1 to Dec. 31, 1991. Software integrator Quarterdeck Office Systems, PC software maker Broderbund Software, and LAN maker Wellfleet Communications also won big, with stock increases of over 100% from IPO date to year-end.

—E. B. Baatz

PRODUCT DEVELOPMENT

CFI pilot program promises framework tools next year

SOFTWARE frameworks are supposed to someday take the pain out of trying to make design tools from different EDA vendors work together. It hasn't happened yet, but new efforts by the CAD Framework Initiative (CFI) consortium may result in commercially available CFI-compliant tools by mid-1993.

CFI has released preliminary versions of Release 1.0., and four of its members—Sun, IBM, Hewlett-Packard, and Siemens Nixdorf—have launched pilot programs with EDA vendors to put real-life technology around CFI's paperbound specs. The IBM program, for example, will use the CFI spec for inter-tool communication to integrate its in-house framework with two commercial frameworks.

Input from these four efforts are expected to help shape a final industry-standard spec, which would be voted on in the fall and made public in December.

Meanwhile, most frameworks still don't work as promised, and CAD managers complain they spend $2 on integration for every dollar spent on tool purchases. "We are overwhelmed by the number of tools and vendors we have to deal with," says Khanh Vu, manager of corporate CAD at Sun Microsystems Inc.

While a real framework standard could make it difficult for EDA vendors such as Cadence Design Systems and Mentor Graphics to cash in on their multimillion dollar investments in proprietary frameworks, it would be a boon for the EDA business at large—possibly a 20% increase in sales, suggests Graham. An effective standard would spur overall sales by enabling customers to spend their current integration budgets on the tools of their choice. At least that's the theory.

Buyer alert: Beware those who claim to have CFI-compliant products today. While vendors have long tried to differentiate themselves on this claim, it can't be true until the final version of Release 1.0 is made public. "Until then, anyone who says they're CFI-compliant has lost credibility," says Dan Cottrell, manager of design automation at IBM's Integration System Technology Division.

—Peter Burrows

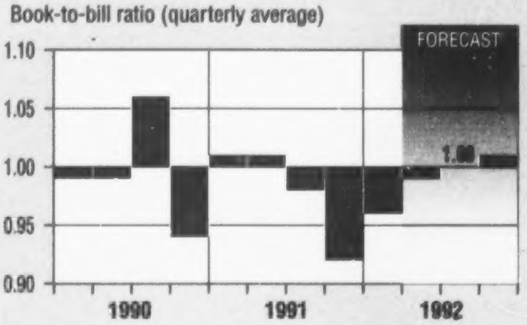
COMPUTERS AND OFFICE EQUIPMENT

Early '92 beats expectations, so forecasts revised upward

EXPECT SHIPMENTS OF computers and office equipment to now climb 8% in 1992 and 10% in 1993. This rosier outlook—compared with Cahners Economics' previous predictions of 4.2% and 6.1%, respectively—stems from the stronger-than-expected showing in the early part of this year. Shipments from U.S. factories swelled to $19.3 billion in the first three months of 1992 (the highest quarterly total ever) and grew 9.7% above year-ago levels (the strongest gain since late 1988).

Despite this recent good news, dollar-valued sales in the next few quarters are likely to fall slightly from first-quarter levels before regaining momentum. Why? First, billings still outrace bookings. The book-to-bill ratio has stagnated below 1.00 for the past seven straight months and isn't expected to rise above parity until the third quarter of this year. Second, backlogs are extremely low and still falling. In March, backlogs dropped 9% from year-ago levels to $9.92 billion—as low as they've been in 14 years. Third, stockpiles are low, too. Inventories shrank 8.7% from March 1991 to March 1992, falling to $9.87 billion.

Book-to-bill ratio (quarterly average)



($ billions)					FORECAST			
Orders	17.6	16.8	17.0	18.5	**18.7**	**18.9**	**19.3**	**21.1**
Shipments	17.5	17.1	18.4	19.3	**18.9**	**18.9**	**19.2**	**20.6**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
		1991				**1992**		**1993**

Source: Commerce Dept.; Forecast: Cahners Economics

Yes, manufacturers have been slashing as a matter of policy in order to reduce costs and boost balance sheets. With the house cleaning just about completed, computer and office equipment vendors will have to slow shipments growth, until underlying demand from consumers and businesses catches up.

—Madeline Franchi

COMMUNICATION EQUIPMENT

Blessed with bloated backlogs, this industry is looking up

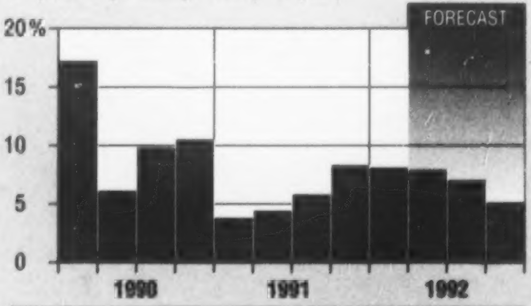
THE COMMUNICATION EQUIPMENT industry beat the averages in 1991 and will continue to do so as Cahners Economics predicts shipments will increase 7% in 1992 and 9% in 1993. Unlike the computer and office equipment sector, which watched shipments retreat 1.4% in 1991, communication equipment company executives enjoyed a 5.6% advance in factory shipments last year. Solid, if not stellar, growth continued into 1992 as first-quarter shipments climbed 8.1% from the year-earlier period and 1.3% from fourth-quarter 1991 levels.

Furthermore, these forecasts hold a good dose of upside possibility because this industry, again unlike the computer industry, is blessed with bloated backlogs. At the end of March 1992, unfilled orders totalled $19.7 billion. Although down 9% from a year ago, communication equipment backlogs now stand 4.4 times higher than March shipments (compared with backlogs that are only 1.6 times shipments in the computer industry).

Adding to the industry's optimism, demand for communication equipment is clearly recuperating early from the recession. After posting a 2.1% loss in 1991, orders popped up 14.2% from year-ago levels in the first three months of this year. Although orders are often volatile from quarter-to-quarter, this resurgence is the real thing. Survey data from the Commerce Department business investment in communication equipment confirm the trend.

—M. F.

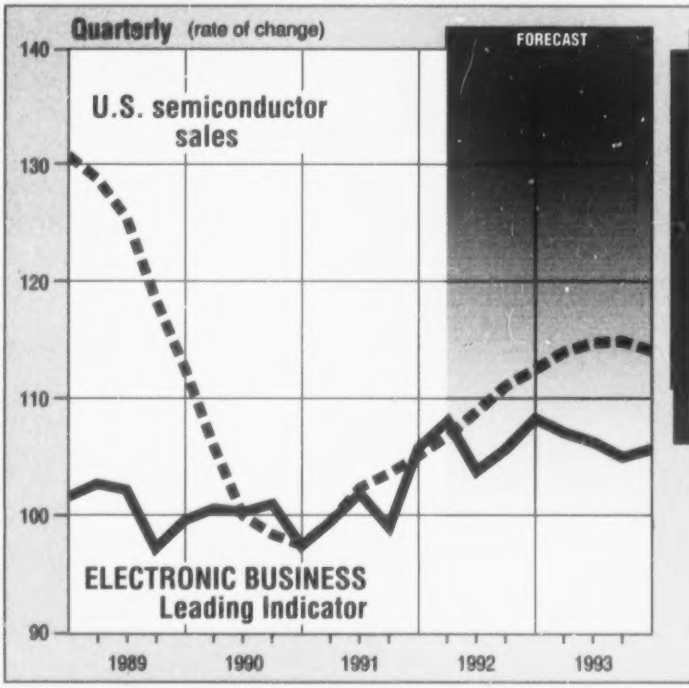
Shipments (% change from prior year)

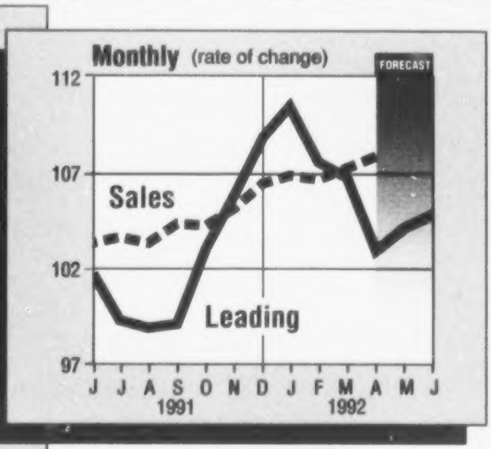


($ billions)					FORECAST			
Orders	11.3	11.5	13.0	13.1	**13.4**	**13.3**	**13.7**	**13.7**
Shipments	12.2	12.5	13.0	13.2	**13.1**	**13.4**	**13.7**	**14.0**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
	1991			**1992**				**1993**

Source: Commerce Dept.; Forecast: Cahners Economics

ELECTRONIC BUSINESS Leading Indicator



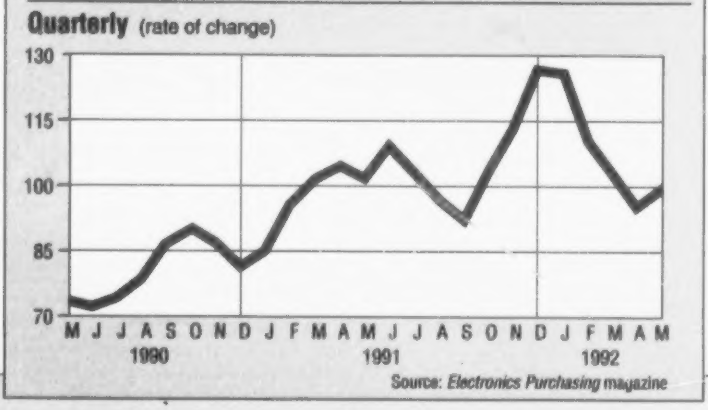


Indicator hits snag in April, temporarily

WHEN THE ELECTRONIC BUSINESS Leading Indicator (EBLI) weakened from 106.7 in March to 102.9 in April, everyone worried about a repeat of last year's aborted recovery, which was recorded by an upward swing to a two-year "peak" of 103.3 in April 1991 and a subsequent mild retreat. However, since the EBLI is based on year-over-year growth, this drop-off is not a dire sign. The EBLI is still on track. Unlike 1991, it is expected to push forward to its next peak of 109.4 in December. The modest recovery moves onward slowly.

—John Farrell

Purchasing's delivery times show erratic trend

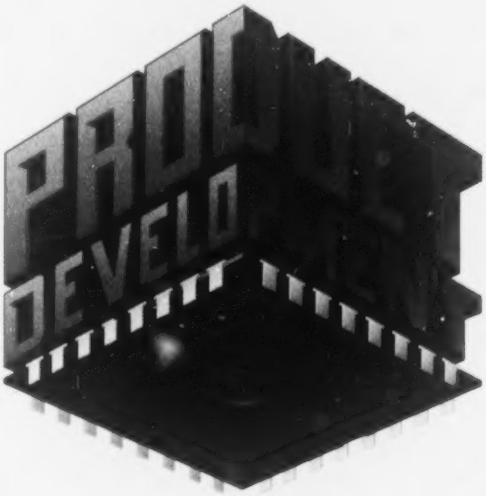


Source: *Electronics Purchasing* magazine

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Apr.)	102.9	106.7	103.3	101.6
U.S. semiconductor bookings ($ millions, 3-month average, Apr.)	$1,570	$1,528	$1,468	$1,311
Weekly hours of semiconductor production workers (monthly average, Mar.)	42.9	42.7	41.1	41.1
Electronic components lead time index (1977 = 100, May)	83.7	81.8	93.3	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, Apr.)	82.1	88.0	74.8	68.5
Change in electronic components inventories ($ millions, SA, Mar.)	-$35	$73	$19	-$53
Contracts and orders for plant and equipment ($ billions, SA, Mar.)	$37.0	$35.4	$35.9	$35.0

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics



Take the BLACK MAGIC out of SOFTWARE DEVELOPMENT

As in hardware, a structured process will produce better software, on time and on budget. Here's how

By Rick Whiting

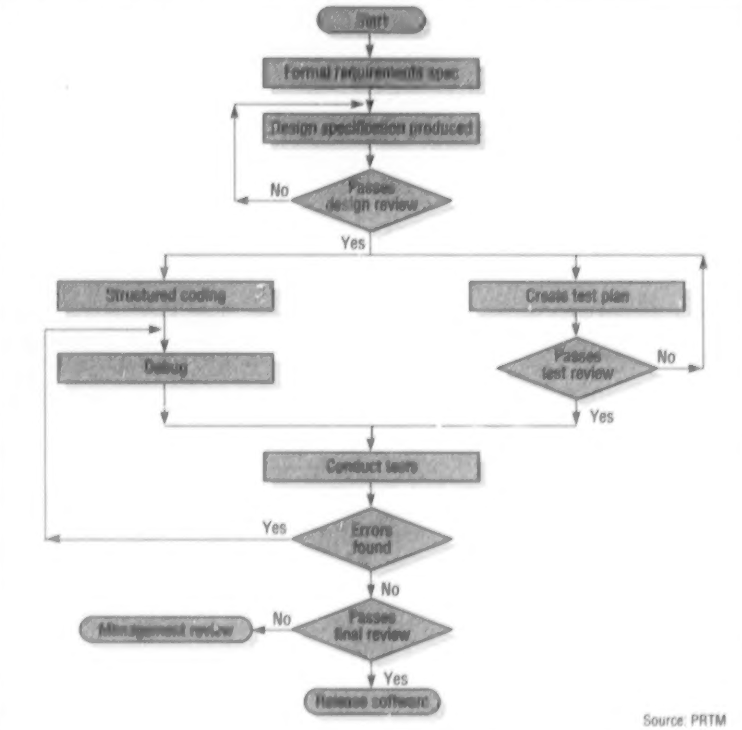
Is software development an art or a process? Ask a dozen people in the computer industry and you'll get a dozen different answers, but nearly all agree on one point: *Managing* software development is a process.

It's also a process more managers are being forced to learn as hardware becomes a commodity and software accounts for an increasing percentage of product value. Often, those charged with overseeing product development find themselves on unfamiliar ground.

Here's the problem: While there are just so many ways to design a computer or lay out a printed circuit board, there are an almost infinite number of ways to write a computer program. The steps for developing software are not as clearly defined as with hardware, and benchmarks for measuring product quality and development process efficiency are rare.

All this can make managing software a nightmare for product development chiefs, many of whom have hardware engineering backgrounds. "Engineering managers feel that they are losing control of the development process," says Louis J. Mazzuchelli Jr., chief technical officer at Cadre Technologies Inc., a Providence, R.I., vendor of computer-aided software engineering (CASE) tools. "There's a lot more ambiguity on the software side. There are no ground rules."

How to structure your software development



Source: PRTM

The result: Software development projects frequently run far behind schedule and over budget. Cost overruns for even small projects average $100,000 and can reach $3 million to $6 million for large-scale efforts, says T. Capers Jones, chairman of Software Productivity Research Inc. (SPR), a Burlington, Mass.-based software consulting firm whose clients include AT&T, Hewlett-Packard, and Digital Equipment Corp. Many projects never see the light of day. Jones calculates that canceled projects consume about 15% of all software development efforts in the U.S. each year, costing some $14.3 billion and a loss of over 285,000 person-years in programming time.

It seems clear that software development remains a mysterious sinkhole for cash and effort for most companies used to developing only hardware. That must change, and fast, as the absolute value of hardware declines. For some companies, it will mean dumping all hardware. For most, it will mean creating a mix of value in hardware and software. Consider the following examples:

Epoch Systems Inc. once built proprietary storage servers to run its software but now just assembles servers from SPARC boards purchased from Sun Microsystems Inc. The Westborough, Mass., company has even begun selling its network data management software without any hardware at all. Marketing vice president Kent Godfrey estimates that 60% of the company's gross margin is earned from software—a figure reflected in the fact that 37 of the company's 40 engineers are software programmers and the company has done no real hardware development for three years.

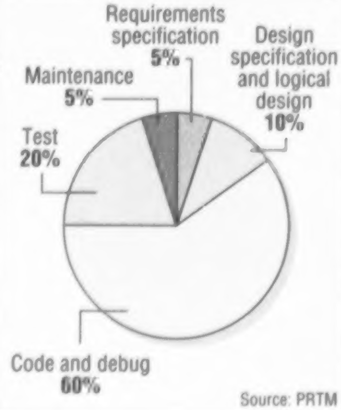
Xylogics Inc. has evolved from a manufacturer of peripheral controller boards to a builder of communications servers and other products. Software today accounts for about 70% of the "value-add" of Xylogics's products, CEO and president Bruce Bergman says, and the Burlington, Mass., company has plans to sell unbundled software. "In just two years we've migrated pretty dramatically," says Bergman. "Software development has always been more difficult to manage. We've done a reasonably good job, but it's hard to get your hands on."

Veritas Software Corp. of Santa Clara, Calif., has made a complete metamorphosis. Originally named Tolerant Systems Inc. in the 1980s, the company manufactured fault-tolerant computer systems before concluding that its real market value was its storage management and quality testing software. When it jettisoned its hardware products in favor of software, "It was a major earthquake of a change in the business," says Mark Leslie, then on the company's board and today president and CEO of Veritas. Of the company's original 45 employees, only a handful remain.

The change from developing hardware to devoting at least an equal effort to software need not be gut-wrenching. "I think that we treat software and hardware development much the same. The tools, terminology, and metrics may be different, but the management issues are the same," says Shelly Lowenthal, AIX systems division engineering director at Cambex Corp., a Waltham, Mass., developer of data storage hardware and software.

Experienced managers say those issues include more effort at the start to clearly define the features of a new product; a tracking methodology to keep projects on schedule and within specifications; a testing process and other techniques to ensure product quality; and strategies for obtaining customer input and incorporating that data into new products.

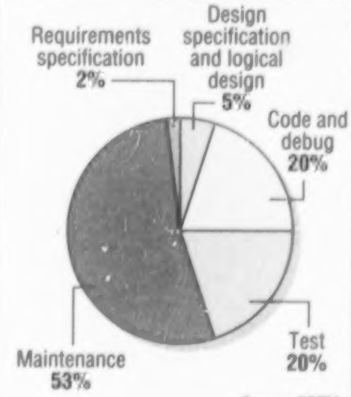
How developers think they spend their time



Source: PRTM

The effect of adopting a structured approach can be dramatic. As much as 50% to 60% of the time needed to develop new software products can be eliminated by instituting a structured development process, "something which most companies don't do," says Mike McGrath, a managing director of the Pittiglio Rabin Todd & McGrath management consulting firm in Weston, Mass.

How developers actually spend their time



Source: PRTM

Epoch, for example, divides its development process into product requirement, design, coding, and internal and external testing phases. Each phase is made up of a half-dozen to a dozen steps, and projects are reviewed before moving on to the next phase. At the end of the product requirements phase, the decision is made whether to fund the project following a review by the company's executive board and finance and marketing representatives.

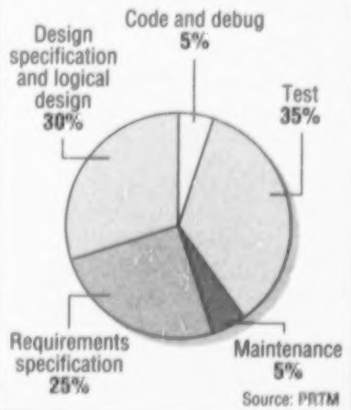
Overseeing the process should be a core or cross-functional team of representatives from a company's various departments, including software engineering, marketing, quality, customer service, documentation, and operations. For a new communications server product under development at Xylogics, a core team conducted customer interviews, drew up the product's specifications, and is now overseeing the development work.

Commercially available tools for planning and tracking software development have been lacking in the past. Jones says, however, that as many as 75 planning tools for project management and 45 automated estimating tools—expert systems used to calculate the resources a development project will need—will be on the market by the end of this year. "Failure to use automated estimating and planning tools for large systems is management malpractice," Jones writes in a draft of a book he is writing on software development problems.

Although most problems are revealed in the late stages of a project, their causes usually can be traced back to failures in the early product development phases. "You'd be surprised at the number of companies that throw a bunch of engineers into a room, give them a project, and let them go at it," says Edward A. Taylor, president of PenCom Software in Austin, which provides software development services to such companies as IBM, Sun Microsystems, and Advanced Micro Devices.

Common problems, says PRTM's McGrath, include ambiguities in product definition, omissions in specifications, and incompatible interfaces between software modules and between software and hardware.

How developers should spend their time



Source: PRTM

Requirements specification, the phase in which a new software product's functionality and target market are defined, should account for about 25% of the total development process, says McGrath. Design specification and logical design, when a detailed product blueprint is drawn up and development schedules are prepared, should account for another 30%. Only 5% of the process should be devoted to actual

Software today: Late, over budget, and full of bugs

JUST HOW SERIOUS are the problems with software development in the U.S.?

Fifty percent of all software projects that are larger than 1,000 function points run over budget, according to Software Productivity Research Inc. chairman T. Capers Jones, who conducts surveys of the software industry. He estimates cost overruns average $100,000 for projects of 1,000 function points and as much as $3 million to $6 million on projects of 10,000 function points.

Function points are catching on as a means of quantifying software. A car fuel injection system, for example, contains between 150 and 600 function points. Software for a PBX system is made up of 1,000 to 5,000 function points, while an operating system has as many as 25,000 to 60,000 function points.

Predictably, larger software projects contained more bugs. Alarmingly, however, Jones found the efficiency rate for correcting those bugs before the software reached the market decreased as the size of the project increased. A relatively simple program with 160 function points, on average, has 500 bugs, 92% of which will be removed before the product hits the market. For a huge project of 40,960 function points, such as an operating system or airline reservation program, only 63% of the potential 250,000 defects will be caught.

Even worse is the time and resources lost on software projects that are ultimately canceled because the product never achieved its intended performance or because the project took too long and the market opportunity was missed.

Canceled software projects, on average, run a year behind schedule and are twice their budget by the time they are killed, Jones's surveys discovered. Canceled projects consume about 15% of all software development efforts each year, costing some $14.3 billion and wasting over 285,000 person-years in programming time. ☐

coding and debugging, McGrath says.

Too often, no one tells this to the programmers. PRTM estimates that most companies spend only 2% of the development process on requirements specification and only 5% on design specification and logical design, while coding and debugging chews up 20% of the process. New product testing should account for 35% of the process instead of the 20% most companies devote to it. The result is that the average company spends 53% of its development time and resources on maintenance instead of the 5% it should take.

Some companies are adding rapid prototyping to the early stages of their development work. By building a scaled-down version of a new product, Veritas engineers learn how long the final product will take to build and what resources it will require. CEO Leslie says the company has even dumped projects after what he calls the "concept exploration" phase. Prototyping also provides a way to try out different approaches or designs to resolve problems.

"The more time you spend up front doing design specifications, the more time you spend with customers, and the more time you spend on prototyping, the more successful your software package will be," says Gary J. Stump, a senior consultant with Technology Edge, a

"Software development has always been more difficult to manage [than hardware]," says Xylogics's CEO Bruce Bergman (right) shown with engineering vice president Bruce Sachs

Dave Bradley

Software for customers —not programmers

KNOWING WHAT the customer wants in a new software product is the first step in software development.

"When you're building hardware, you really don't need to be that close to the customer's needs. You only need to build a product that is competitive in price/performance," says Gary J. Stump, a senior consultant with Technology Edge, a Boise, Idaho, consulting firm. That won't cut it in software where products must be particularly tailored to customer needs.

Sending engineers to meet with intended customers is the most basic idea. Companies "need to get their development staffs out with customers so that their engineers become sensitized to customer needs," Stump says. That should occur during the early planning stages for a new product and when developers have a working model. "The best thing you can do is go back to the customer and hear him say: 'No, that's not what I wanted.' That's defect removal at an early stage," Stump adds.

Companies can also bring the customers to them by bringing on board advisers with expertise in the target market: a chemist, for example, to help oversee development of software for chemists. "You need someone who speaks customer-ese," Stump says. "They keep everyone honest."

Veritas Software Corp., a Santa Clara, Calif. hardware-turned-software company, has customers on a panel that examines product ideas during a "concept review" stage—before coding work begins. Currently, a Wall Street trading firm executive is among those providing input for new products.

Xylogics Inc., a Burlington, Mass., vendor of communication servers and controllers, keeps close ties with such leading-edge customers as NASA and universities. The assumption is that product features they want today will be in general demand tomorrow.

By reducing the need for redesigns and other cleanup work, collecting customer data and developing a market requirements document for a new software product can cut a project's development time by 30% to 40% and its cost by 50%, says Jeff Schlageter, engineering vice president at Actel Corp. in Sunnyvale, Calif. ☐

Boise, Idaho, management consulting firm.

Still, given that many consider programming to be an art, there is always the danger of bringing *too much* structure to software development. The same process and metrics that support weaker employees can prove stifling to superstar programmers, says Dan Rourke, a senior programmer with IBM's personal systems programming operation in Austin. "It's important to maintain the creativity and innovation that we want to see," he says.

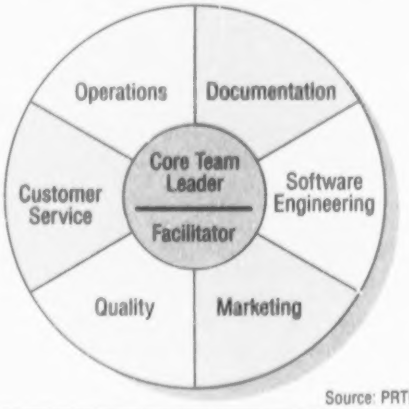
Quality and test assurance is another hurdle that companies frequently trip over. "Most hardware companies believe they can test software the same way they can hardware," Stump says. While hardware can be checked by running it non-stop for weeks, there is no way to test software for every circumstance. Bugs may crop up only under certain conditions and are often not discovered until long after the software has been released, says T. Michael Nevens, a principal with the McKinsey & Co. consulting firm.

Correcting a bug in a product that's already shipped can cost from $5,000 to $25,000, depending on the code complexity and the size of the installed base, estimates Veritas's Leslie.

SPR's Jones says that quality assurance should be separate from the rest of the development organization and should have its own chain of command and the power to halt a project. Rather than play a passive observer role, a quality assurance department should aggressively collect and analyze defect data, develop and run test programs, and teach courses on

Core team at the center of software development

Core team members overseeing software development represent all segments of a company



Source: PRTM

How to tell if you're developing quality software

SOFTWARE DEVELOPMENT is a young field and, at best, an inexact science. As a result, few industry-standard tools, methodologies, and metrics exist for measuring product quality and process improvement.

"The biggest problem with software is that you never really know where you're at," says Fred Molinari, president of Data Translation Inc., a Marlborough, Mass., supplier of data acquisition software and boards.

Managers, consultants, and assorted industry gurus disagree over how to measure software *quantity*. Lines of code can be deceiving since one programmer can solve with 10 lines of code a problem that may take another programmer 25 lines. That makes bugs-per-line of code an imprecise measure of product and process quality. Even the definition of "bug" is murky: If a program freezes when a user makes a wrong keystroke, is that a defect?

More managers are turning to function points as a more definitive way of measuring software. Function points are made up of a weighted combination of inputs, outputs, inquiries, logical files, and interfaces that describe a software program's features. A computer-aided design tool may contain 600 to 2,500 function points, for example, while an operating system may have 25,000 to 60,000 function points.

Industry-leading software has an average of .02 defects per function point, estimates T. Capers Jones, chairman of Software Productivity Research Inc. in Burlington, Mass. Jones says that while such companies as Hewlett-Packard Co., AT&T, and IBM are approaching that level, most software with bug counts that low are found in advanced weapons systems such as Raytheon Co.'s Patriot missile. Jones believes that the industry average for software defects is in the range of 0.2 or 0.3 per function point.

Given the inherent ambiguities in software, managers are putting more emphasis on trend analysis—in effect, comparing a company's development process efficiency or product quality with itself.

For example, Arthur Zachai, a senior consultant with Arthur D. Little Inc., suggests tracking how many changes are made in code that has already been written. "It's a very powerful, simple metric," he says. If a program has 1,000 lines of code and 100 lines are being changed every week, "you're nowhere near having a product for release."

Other useful trend-analysis metrics include the number of defects discovered per 100 hours of testing and the number of defects per root cause—bugs traced to a specific problem such as poor feature specification or interface definition.

An increasing number of companies are adopting a methodology created by the Software Engineering Institute at Carnegie Mellon University to assess how their software development procedure stands up. ☐

How does your software development measure up?

Example	**Project size in function points**	**Length of project** (months)	**Number of programmers**	**Project cost** ($ millions)	**Potential # defects**	**% defects removed before released**
Car fuel injection system	160	9	2	95	500	92
Simple word processor	640	16	10	800*	2.2*	85
Advanced spreadsheet, PBX	2,560	29	45	6.5	10.2*	79
CASE tool, insurance claim program	10,240	53	200	52.5	51*	72
Operating system, airline reservation system	40,960	96	900	430	250*	63

*Thousands

Source: Software Productivity Research

Where the programmers are

Software developers and their managers by country in 1990

Country	Programmers	Managers	Total
USA	1,693,200	253,980	1,947,180
USSR	1,445,000	216,750	1,661,750
India	1,252,500	187,875	1,440,375
China	990,000	148,500	1,138,500
Japan	850,000	127,500	977,500
Germany	505,600	75,840	581,440
Indonesia	460,000	69,000	529,000
Brazil	441,000	66,150	507,150
England	370,550	55,575	426,075
Italy	365,400	54,810	420,210
France	364,000	54,610	418,600
Mexico	261,000	39,150	300,150
South Korea	236,500	34,475	271,975
Spain	234,000	35,100	269,100
Thailand	196,000	29,400	225,400
Turkey	192,500	28,875	221,375
Poland	190,000	28,500	218,500
Canada	169,000	25,350	194,350
Egypt	137,500	20,625	158,125
Taiwan	116,000	17,400	133,400
Total	10,469,700	1,567,465	12,040,155

Source: Software Productivity Research

quality improvement, Jones says.

Xylogics has split its quality assurance operation off from the development group to allow programmers more time to concentrate on new products, says engineering vice president Bruce I. Sachs. Veritas takes the opposite stance and has no quality assurance department, opting instead to make each development group responsible for the quality of its own work.

As with planning tools, commercially available tools to test new software products are scarce, and most companies use test programs developed in-house. The good news is that more bug-remover software is becoming available. Veritas, for example, received so many requests for its Vista test program that the company has put the product on the market.

If a project is relatively small in scope, hardware and software development teams should work closely together—if not physically side by side—with representatives of each sitting on the other's core team. For large projects, where hundreds of engineers may be involved, the hardware-software interface should be defined and documented early in the specification and design phases. And hardware prototypes built early in the process allow hardware and software to be tested together sooner.

McKinsey's Nevens says the increased use of networked workstations by hardware and software engineers is improving inter-team communications and reducing the number of end-of-the-process snafus that usually plague development projects.

Software programmers in the past have been the poor relatives among engineering disciplines in terms of capital investment. SPR's Jones estimates that the average electrical or mechanical engineer may have as much as $200,000 worth of computers, software, and other equipment at his or her disposal—a far cry from the $20,000 or so that Jones says that software engineers have.

Nevens believes that is changing as workstations become cheaper and more software development tools become available. "People are beginning to understand that you have to have the capital investment behind the programmer to make him truly productive," he says.

Leading-edge companies are also adopting object-oriented programming (OOP) technology to boost development process efficiency and product quality. Using OOP, a developer can "encapsulate" bits of software code and reuse them to assemble new programs rather than write each program from scratch. Actel Corp., in Sunnyvale, Calif., has seen programmer productivity improve by 50% by using C++, an object-oriented programming language, according to architecture staff engineer Telle Whitney.

OOP also has a subtle benefit for hardware companies wrestling with software. Because OOP uses pieces of software as components from which to assemble new products, the technique follows more closely the way hardware engineers traditionally think.

Don't be misled. CASE, OOP, and other tools will fail unless used as part of a process. Managers often fall into the trap of thinking that CASE tools are silver bullets to solve all of their development problems.

"A fool with a tool is still a fool," says Anthony I. Wasserman, president of CASE software supplier Interactive Development Environments Inc. in San Francisco. ☐

How does your software operation stack up? (Probably lousy)

A system for grading and improving the process promises to help you smooth out those software development lumps

By Peter Burrows

One key problem for software developers is knowing how their process rates against the state of the art. There's simply been no objective tool by which engineers could grade, or even describe, the largely subjective task of generating a new program.

There still is no such tool, but the Software Engineering Institute (SEI) at Carnegie Mellon University in Pittsburgh is establishing itself as a starting point. Consisting of a rudimentary software maturity model that segments the discipline into five "grades" of proficiency and a process-improvement process designed to bring hardware-style discipline to the "art" of software engineering (see chart), the SEI offers a system to help companies find where they are and where they must go.

"It provides a very articulate way to isolate your strengths and weaknesses and helps you focus less on your people and more on your processes," says Ronald Madsen, U.S. software process improvement program manager for Digital Equipment Corp. "It is becoming the de facto model to describe good software engineering practices."

Some warn that the SEI tool could be used not as a software-development aid but as an arbitrary weapon. Others argue that it offers trivial answers to complex problems. Advocates point out, however, that its purpose is not to give answers at all; rather, it provides a framework to ensure that solid engineering practices are being followed within the software organization. Using the SEI system does not, for example, preclude engineering management from implementing computer-aided software engineering (CASE) tools or object-oriented programming—it just requires that they be used in a controlled, well-managed manner.

Here's how it works. Interested companies either assess themselves or bring in one of the nine consultancies licensed by the SEI (see

SEI's software report card

Maturity level	Selected characteristics	% of U.S. companies (based on 1990 survey of 55 projects)
Level 5 "Optimized"	• Improvements fed back into process • Automated data gathering • Rigorous defect-cause analysis and defect prevention	0%
Level 4 "Managed"	• Measued process • Some quality and productivity measurements • Established process database with resources to analyze and maintain data	0%
Level 3 "Defined"	• Defined and institutionalized process • Established Software Engineering Process Group	4%
Level 2 "Repeatable"	• Process dependent on individuals • Basic project controls • Good at incremental change; bad at major change • No orderly framework for improvement	22%
Level 1 "Initial"	• No formal procedures, cost estimates, or project plans • Few controls, little tool integration • Little senior management input	74%

Source: Software Engineering Institute

SEI's software improvement process

Step	Time
Get management's commitment	Indefinite
Prepare for process improvement program: • Choose SEI-licensed assesor or in-house team • Determine group to be assessed • Create a process improvement team	2-10 months
Conduct assessment: • Hold opening meeting with management and participants • Interview project leaders, functional area representatives and other participants • Hold other discussions as appropriate • Review preliminary findings with project leader and other participants • Present findings to management and all participants	1 week
Develop report with recommendations for attacking priority areas for improvement	1-2 months
Develop action plan that accounts for: • Resource allocation • Scheduling • Responsibility delegation • Management review process	6-12 months
Improve • Implement quantitative process management • Fill in gaps in training • Move toward software-engineering discipline	Expect 2-4 years to go from Level 1 to Level 2 1-3 years to Level 3 1-3 years to Level 4 1-3 years to Level 5
Reassess	Every 1½ years

Source: Watts Humphrey, founder of SEI's software process program

chart). The assessment, which includes questionnaires and a week of interviews with managers and software developers, tells the company which of the five categories it fits into and what its key problems are. Working either with the consultant or alone, the company sets up a process-improvement team and uses SEI guidelines to attack problem areas.

The process is expensive up-front—assessors usually charge about $40,000 per organization and the improvement process typically requires large investments in time and manpower. Also, expect progress to be slow. To go from Level 1 to Level 5—which no company has done so far—would take about 10 years, says Humphrey.

But success does come to those who wait. Hughes Aircraft says it spent $45,000 on an assessment and $400,000 on a two-year improvement program but ultimately saved about $2 million in time-to-market savings, reduced costs, and improved employee morale.

Why has the SEI risen to the fore? First, it is fully funded by the world's largest software user, the Department of Defense, which formed the SEI in 1984 after studies showed that only a fraction of its software projects were coming in on time and on budget. Also, the SEI represents one of the more impressive collections of software experience outside of proprietary R&D labs. Of its 168 technical staffers, 74% came from industry and more than 44% have at least 20 years' experience.

In all, the SEI and its consultants have performed about 80 assessments. This includes only a handful of commercial outfits, but interest is on the rise at companies such as DEC, IBM, Motorola, Unisys, and others, which are increasingly using it as a tool to extend their total quality management programs to the software realm.

While the SEI system was designed to be used in such a spirit of self-improvement, interest is also being driven by other motives. For one, the European Community (EC) has published guidelines as part of its ISO-9000 regulations that require software companies to have strictly defined quality systems in place in order to sell software in the EC. Many electronics companies, most of whose software operations lack the quality systems that enabled them to comply with ISO-9000 directives for certain classes of hardware, see the SEI system as a tool to satisfy the requirement.

For more information on the SEI, call (412) 268-6257. ☐

Third-party assessors licensed by SEI

American Management Systems Inc., San Diego, Calif. (619) 297-5800

Arthur D. Little Inc., Burlington, Mass. (617) 272-1770

Dayton Aerospace Associates Inc., Beavercreek, Ohio (513) 426-4300

Digital Equipment Corp., Englewood, Colo. (303) 649-3484

Pragma Systems Corp., Falls Church, Virginia (703) 560-4669

Software Productivity Consortium, Herndon, Virginia (703) 742-7216

Process Inc. Kington, Ontario (613) 531-9972

Technology Applications Inc., Alexandria, Virginia (703) 461-2053

The Process Enhancement Partnership, Silver Springs, Maryland (301) 587-1315

39% of companies use a formal product development protocol

That's the good news. Sadly, almost as many companies don't, and they have no plans to do so soon

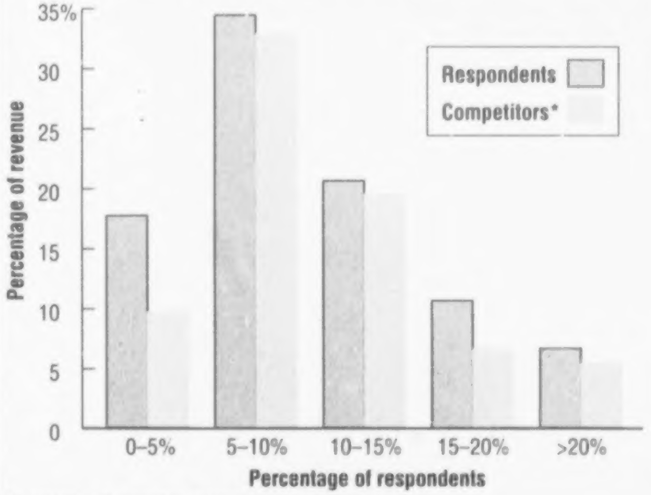
How important is new product development to your company's success? The obvious answer, of course, is that it's vital. ELECTRONIC BUSINESS has long wanted to understand in more detail how companies perceive and pursue this important activity and to what extent they rely on supplier partnerships in the process. When DuPont Electronics suggested that we jointly conduct a survey to learn the answers, we jumped at the chance. The results are revealing and often startling. For example, U.S. manufacturers still prefer Japanese partners for quality. That's alarming.

Here's a quick look at the demographics. We surveyed 254 companies, 38.6% of which generated more than $1 billion in annual revenue. Another 13.4% represented companies generating between $250 million and $1 billion in revenue, and the remaining companies represented those that had less than $250 million. More than a quarter of the respondents were computer companies; 13% were semiconductor manufacturers; 12.6% were communications companies; and the rest represented the automotive, consumer, military, industrial control, and test and instrumentation segments.

We hope this snapshot of how your colleagues and competitors approach product development provides fodder for your planning process.

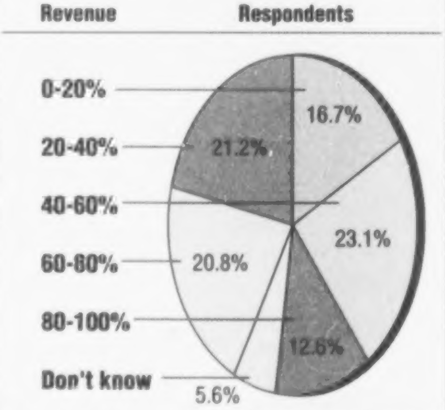
How much do you spend on product development?

Percentage of revenue spent on new product development



*Respondents' perception of competitors' spending

What percentage of your company revenue is from products developed in the last 3 years?

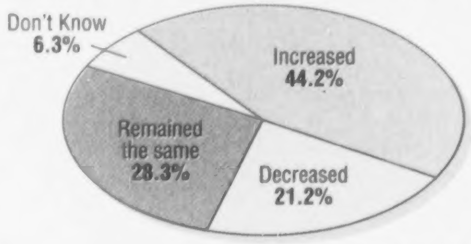


Source: ELECTRONIC BUSINESS and DuPont

IT'S HARDLY A SURPRISE that virtually all respondents to the joint ELECTRONIC BUSINESS-DuPont survey report that new product development is critical to their success. Not only are companies spending more on product development than in the past—and receiving greater returns—but also respondents say that they are under greater pressure to develop new products faster and with higher quality than ever before. Having acknowledged that, it's worth noting that more than a third of the respondents do not have a formal product development process. Thirty-nine percent have structured protocols, and the remainder report using partially implemented protocols.

Companies are spending more on development

How has your company's percentage of revenue spent on new product development changed versus 5 years ago?



Source: ELECTRONIC BUSINESS and DuPont

There seems to be growing acceptance of the fact that no company can go it alone and succeed. To that end, manufacturers throughout the electronic food chain expect to include their suppliers in the product development process. Conversely, although manufacturers report they want to involve suppliers more deeply in the design process, they also remain willing to dump suppliers for a small price difference. ☐

Why companies partner with suppliers

Top partnering benefit by supplier category

	Materials	Components	Board subsystems	Contract manufacturing
Lower total cost	59.1	55.8	45.4	54.4
Shorter time-to-market	40.4	51.5	49.2	46.8
Better quality	40.4	32.0	31.1	20.3
Minimize capital investment	24.9	18.0	25.1	40.5
Other	22.7	30.5	21.8	19.6
N/A	0.0	0.0	1.1	1.3

Multiple responses allowed; % respondents

Source: ELECTRONIC BUSINESS and DuPont

Japan still wins on quality

What are the advantages of partnering with U.S. and Japanese suppliers (% of respondents)

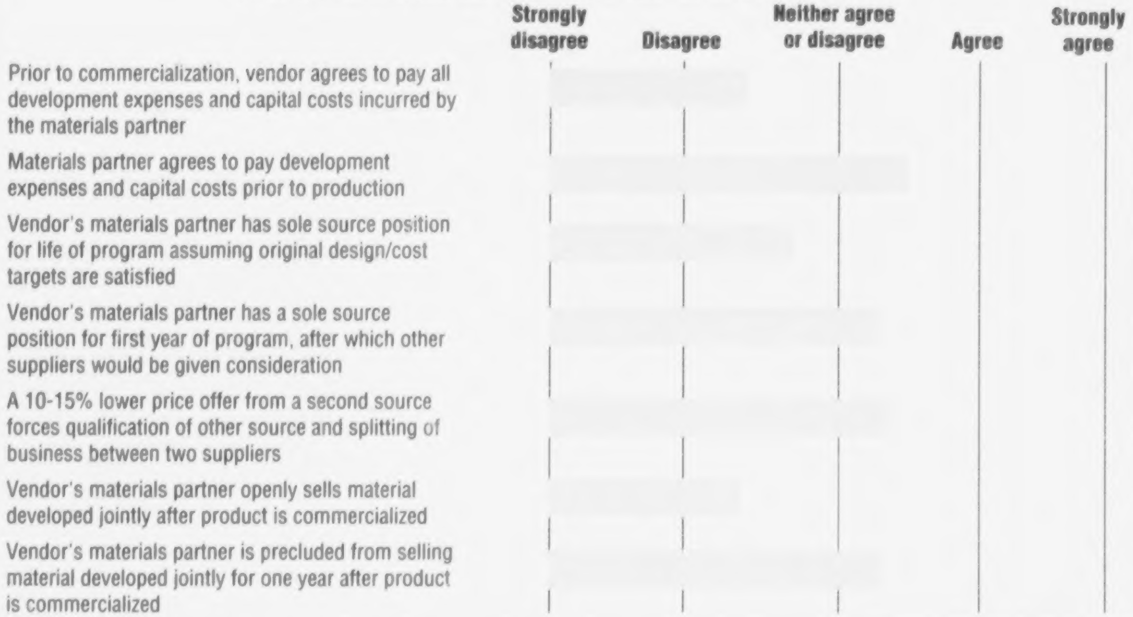
Japan/**U.S.**	Materials	Components	Board subsystems	Contract manufacturing
Product quality	71.5/35.9	67.7/28.4	63.4/24.4	59.5/25.8
New product leadership	39.2/24.3	44.9/31.6	31.7/27.9	18.9/16.4
Pricing	38.6/19.4	40.7/18.6	39.0/21.5	43.2/24.5
Ease of communications	0/31.1	0/29.3	0/27.9	0/32.1
Cycle-time responsiveness	8.2/16.0	9.0/14.4	11.4/21.5	12.6/31.4
Technical support	13.9/30.6	10.8/37.7	17.1/31.4	11.7/23.9
Openess and trust	1.9/5.3	1.2/5.6	2.4/6.4	4.5/7.5

Multiple responses allowed

Source: ELECTRONIC BUSINESS and DuPont

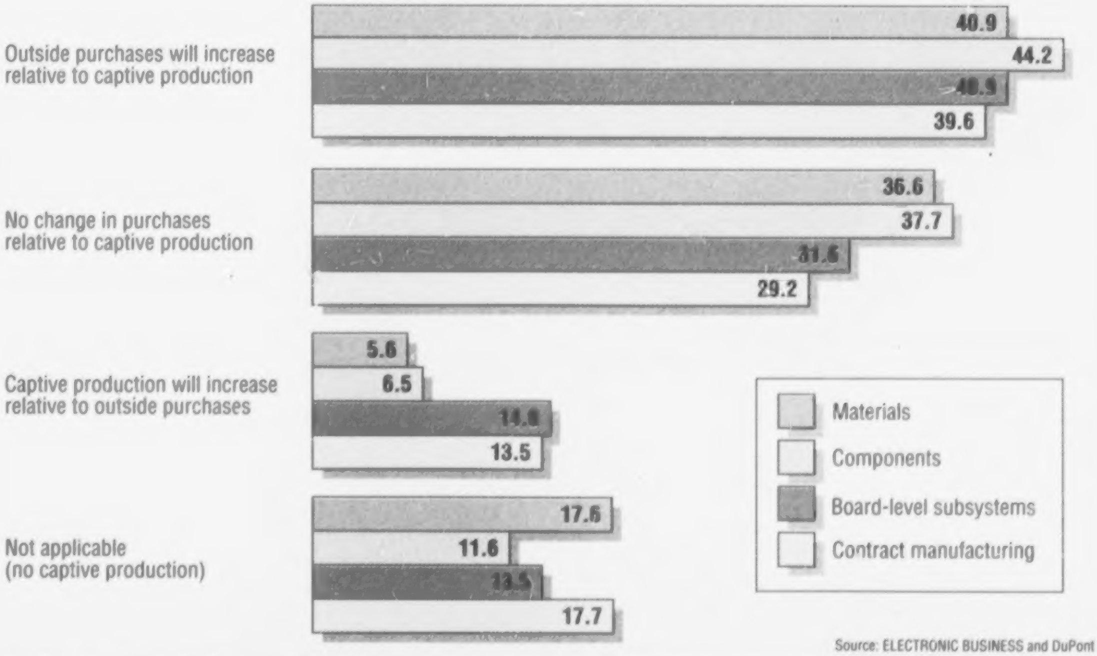
How does your partnering measure up?

Vendors' responses to the following are based on the hypothetical assumption that they have partnered with a supplier and are in the commercialization/production phase



How will your dependence on outside suppliers change?

(Suppliers use over next 3 years; % respondents)



Source: ELECTRONIC BUSINESS and DuPont

CEO's say product development is vital

(% ranking important factors critical to their competitiveness)

		Ranking		
		1991*	1992	1996**
Product quality	67%	3	1	1
Customer service	65	4	2	2
New product development	52	NA	3	3
Technology innovation	50	1	4	4
Attract and retain key people	45	2	5	6
Time to market	42	7	6	5
Capital availability	32	5	7	10
Organized excellence	32	6	8	7
Proprietary intellectual property	24	8	9	8
Access to foreign markets	22	9	10	8
Supplier realationships	20	10	11	11
Strategic alliances	15	NA	12	12

Multiple responses allowed; NA=Not available

*Ranking from 1991 CEO survey **CEO's anticipated ranking

Source: ELECTRONIC BUSINESS and DuPont

What kind of partner are you?

How would you share costs and benefits with a supplier on a successful joint venture (% respondents)

	Agree	Neither agree or disagree	Disagree	Don't know
Prior to commericalization we would pay all development expense and capital costs incurred by our materials partner.	14.0	20.5	46.2	17.3
We would expect materials partner to pay their development expenses and capital costs prior to commericialization.	45.4	23.3	13.6	15.7
Our materials partner would have a sole source position for life of the program assuming original design/cost targets are satisfied.	27.3	19.3	36.2	14.5
Our materials partner would have a sole source position for the first year of the program, after which alternatives would probably be given strong consideration.	37.4	23.7	20.4	14.9
A 10-15 percent lower price offer from a second source would force qualification if other source and splitting of business between two suppliers.	40.1	24.1	16.8	16.4
Our materials partner would be able to openly sell materials developed jointly after our new product is commericalized.	20.1	22.1	39.0	16.9
Our materials partner would be precluded from selling materials developed jointly for one year after our product is commericalized.	38.6	23.3	14.8	20.1

Source: ELECTRONIC BUSINESS and DuPont

VENTURE
CAPITOL
DIRECTORY

Whos' on the VC list

Companies on the list responded to a mailed survey by ELECTRONIC BUSINESS. Interestingly, a few who responded asked not to be included. If your company was omitted, please send its name and address to ELECTRONIC BUSINESS so we may include you in next year's survey. You must respond to our mailed survey to be listed. For more information about venture capital companies: call the National Venture Capital Association at (703) 528-4370.

			No. of companies funded		Investment ($ millions)			
Company/Address	**Contact/Phone**	**5-year outlook***	**Electronics**	**Total**	**Electronics**	**Total**	**Total paid in capital ($ millions)**	**Some companies funded**
Accel Partners One Palmer Sq. Princeton, NJ 08542	Don Gooding (609) 683-4500	▲	$42	$50	105	130	$220	Santa Cruz Operation, Broad Band Technologies, Unify, Teleos
Advanced Technology Ventures 10 Post Office Sq. #970 Boston, MA 02109	Albert E. Paladino (617) 423-4050	▲	10	18	11	20	60	Actel, Microwave Networks, Transwitch
Advent International 101 Federal St. Boston, MA 02110	Patrick J. Sansonetti (617) 951-9400	=	46	146	90	290	650	Interleaf, SystemSoft
Alpha Partners 2200 Sand Hill Rd. #250 Menlo Park, CA 94025	Brian J. Grossi (415) 854-7024	▲	14	19	46.6	59.2	58.6	Pinnacle Systems, Bell Microproducts, Network Peripherals
Applied Technology One Cranberry Hill Lexington, MA 02173	Gina Rogers (617) 862-8622	▲	13	15	13.6	15	NA	Fluent Machines, Information Storage Devices, Reflection Technology
Aspen Ventures 3000 Sand Hill Rd. #3-105 Menlo Park, CA 94025	David Crockett (415) 854-3300	=	40	80	70	130	150	None supplied
Atlas Venture One Cambridge Center Cambridge, MA 02142	Barry Fidelman (617) 621-1600	▲	NA	NA	100	150	200	Bachman Information Systems, Chipcom, Viewlogic Systems
AVI Management Partners 3000 Sand Hill Rd. #3-280 Menlo Park, CA 94025	Peter L. Wolken (415) 854-0930	▲	32	32	50	50	65	Power Up Software, Echelon, Maspar Computers
BancBoston Ventures 100 Federal St. Boston, MA 02110	Henry W. Newman (617) 434-2442	=	10	44	6	36	NA	WaveTracer, SunDisk, In Focus Systems
Batterson Johnson & Wang 303 W. Madison #1110 Chicago, IL 60606	Leonard A. Batterson (312) 269-0300	=	NA	16	8.4	13	33	Answer Computer, IKOS Systems, Clear Communications
Battery Ventures 200 Portland St. Boston, MA 02114	Richard D. Frisbie (617) 367-1011	=	40	40	55	55	75	Marcam, In Focus Systems, Banyan Systems

* ▲ expect to increase investment, ▼ decrease, = stay the same, NA = not available

VENTURE CAPITOL DIRECTORY

Company/Address	Contact/Phone	5-year outlook*	No. of companies funded		Investment ($ millions)		Total paid in capital ($ millions)	Some companies funded
			Electronics	Total	Electronics	Total		
Bessemer Venture Partners 83 Walnut St. Wellesley Hills, MA 02181	William T. Burgin (617) 237-6050	▲	15	70	30	100	100	Parametric Technologies, Network Management
Boston Capital Ventures 45 School St. Boston, MA 02108	James Houlihan (617) 227-6550	=	NA	NA	NA	NA	65	Revelation Technologies
Brantley Venture Partners 20600 Chagrin Blvd. Shaker Heights, OH 44122	Robert P. Pinkas (216) 283-4800	▲	9	18	8.8	18.5	45	RF Microdevices, DeCrane Aircraft Holdings, Inplex
Brentwood Associates 11150 Santa Monica Blvd. #1200 Los Angeles, CA 90025	G. Bradford Jones (310) 477-6611	=	30	60	90	NA	400	Media Vision, Wellfleet Communications, Lucid
Burr, Egan, Deleage & Co. One Post Office Sq., #3800 Boston, MA 02109	Jonathan Flint (617) 482-8020	=	13	116	46	270	450	Powersoft, Broderbund, Cadre
Canaan Partners 105 Rowayton Ave. Rowayton, CT 06853	Jim Fitzpatrick (203) 855-0400	▲	NA	NA	35	100	300	Anadigics, Comstream, Clearpoint Research
Charles River Ventures 67 Batterymarch St. Boston, MA 02110	Michael J. Zak (617) 439-0477	▲	20	30	133	200	250	Cascade Communications, Mainstream Software
Charter Venture Capital 525 University Ave. #1500 Palo Alto, CA 95301	A. Barr Dolan (415) 325-6953	▲	15	30	NA	NA	NA	Metricom, Interfax, ELF Technologies
Chatham Venture 420 Bedford St. Lexington, MA 02173	Euan Malcolmson (617) 863-0970	=	10	10	27	27	25	Banyan Systems, Videotelecom, Wall Data
Concord Partners 535 Madison Ave. New York, NY 10022	John Foster (212) 906-7100	=	18	45	50	150	180	SunDisk, Dayna Communications, Read-Rite
Continental Illinois Venture 231 LaSalle St. Chicago, IL 60697	Marcus Wedner (312) 828-8021	▲	3	20	NA	100	NA	None Supplied
Cornerstone Ventures 2420 Sand Hill Rd. #202 Menlo Park, CA 94025	J. Michael Gullard (415) 854-2576	=	20	20	13	13	21	Photonics, Southwest Network Services, Rasna
Crosspoint Venture Partners One First St. Los Altos, CA 94022	John Mumford (415) 948-8300	▲	30	50	60	100	120	STAC, Photonics, Adaptive Solutions
Dajen Consulting 9 Lundy Ln. Larchmont, NY 10538	Robert Cohen (201) 947-4945	=	1	2	NA	NA	NA	None Supplied
Dougery, Jones & Howard 155 Bovet Rd. #650 San Mateo, CA 94402	John R. Dougery (415) 358-8701	▲	45	50	90	100	130	In Focus Systems, Intevac, Abtox
Drysdale Enterprises 859 Promontory Dr. West Newport Beach, CA 92660	George Drysdale (714) 675-5577	▲	4	8	NA	NA	20	None Supplied
E.M. Warburg, Pincus & Co. 466 Lexington Ave. New York, NY 10017	William H. Janeway (212) 878-0600	▲	20	85	250	2,100	2,100	None Supplied

* ▲ expect to increase investment, ▼ decrease, = stay the same; NA = not available

VENTURE CAPITOL DIRECTORY

Company/Address	Contact/Phone	5-year outlook*	No. of companies funded		Investment ($ millions)		Total paid in capital ($ millions)	Some companies funded
			Electronics	Total	Electronics	Total		
Eastech Management 260 Franklin St. #530 Boston, MA 02110	Michael H. Shanahan (617) 439-6130	=	16	18	28	30	34	Unifi Communications, Banyan Systems, Pilot Software
EG&G Ventures 700 E. El Camino Real #270 Mountain View, CA 94040	Andres A. Buser (415) 967-2822	=	8	19	14	33	48	None Supplied
El Dorado Ventures 2 North Lake Ave. #550 Pasadena, CA 91101	Brent Rider (818) 793-1936	▲	20	21	58	60	95	Novellus Systems, Cellular Data, Voice Soft
Euclid Partners 50 Rockefeller Plaza New York, NY 10020	Milton J. Pappas (212) 489-1770	▲	9	15	NA	NA	50	Crosscom, Banyan Systems, Itron
Fidelity Capital 82 Devonshire St. #R25C Boston, MA 02109	Neal Yanofsky (617) 728-6846	▲	5	19	14	110	160	Acticom, Imaging Technology, Advanced Mobilcomm
First Century Partners 1345 Avenue of the Americas New York, NY 10105	Michael J. Myers (212) 698-6383	▲	18	43	48	110	130	Evernet Systems, SuperMac Technology, Automation Partners
Fostin Capital P.O Box 67 Pittsburgh, PA 15230	Joel P. Adams (412) 928-1409	=	14	50	85	17	85	Southwest Network Services, Metcal, Suprex
Geocapital Partners 2115 Linwood Ave. Fort Lee, NJ 07024	Richard Vines (201) 461-9292	▲	24	24	35	35	45	Catalina Marketing, Fifth Generation Systems
Glenwood Management 3000 Sand Hill Rd., #4-230 Menlo Park, CA 94025	Dag Tellefsen (415) 854-8070	=	15	20	30	43	70	Paradigm, Magellan, Biological Components
Glynn Capital Management 3000 Sand Hill Rd., #4-235 Menlo Park, CA 94025	John W. Glynn (415) 854-2215	▲	19	26	16	22	25	Banyan Systems, Ultranetwork Technologies, Celeritek
Grace Horn Ventures 20300 Stevens Creek Blvd., #330 Cupertino, CA 95014	Mark Dubovoy (409) 725-0774	▲	NA	NA	38	60	82	Minister Peripherals, ELF Technologies
Greylock Management One Federal St. Boston, MA 02110	William H. Helman (617) 423-5525	▲	42	66	73	132	300	Xircom, Banyan Systems, Checkfree
Hambro International Equity Partners 650 Madison Ave. New York, NY 10022	Julie Lane (212) 223-7400	=	45	73	69.5	139.2	150	Avatar Technologies, IDE, Rasna
Highland Capital Partners One International Pl. Boston, MA 02110	Paul A. Maeder (617) 330-8765	▲	6	17	18	50	150	Sybase, Avid Technology, Checkfree
Hill, Carman, Kirby & Washing 885 Arapahoe Ave. Boulder, CO 80302	John G. Hill (303) 442-5151	=	4	48	5	70	118	Crystal Semiconductor, Seattle Silicon
HMS Capital Partners 170 Middlefiled Rd. #150 Menlo Park, CA 94025	R.G. Grey (415) 324-4672	=	13	16	11	13	19	Multipoint Networks, Meridian Data Systems
Hook Partners 3102 Oak Lawn Ave. The Centrium #545 Dallas, TX 75219	David J. Hook (214) 528-5451	=	24	25	20	21	25	Vitesse Semiconductor, Slate, Triquint Semiconductor

* ▲ expect to increase investment, ▼ decrease, = stay the same; NA = not available

FINANCE & ECONOMICS

VENTURE CAPITOL DIRECTORY

Company/Address	Contact/Phone	5-year outlook*	No. of companies funded		Investment ($ millions)		Total paid in capital ($ millions)	Some companies funded
			Electronics	Total	Electronics	Total		
IAI Venture Capital Group 3800 First Bank Pl., Box 357 Minneapolis, MN 55440	Thomas G. Kamp (612) 376-2835	=	10	30	30	123	160	Tricord Systems, Racotek, Computer Aided Service
Idanta Partners 10975 Torreyana Rd. #304 San Diego, CA 92122	Dev Purkayastha (619) 452-9690	▲	5	5	11	11	100	Iomega, Stac Electronics, Pacific Communication Sciences
Indosuez Ventures 3000 Sand Hill Rd. #2-160 Menlo Park, CA 94025	David E. Gold (415) 854-0587	=	20	25	NA	NA	34	Informix, Digital Research, Cisco Systems
Inman & Bowman Four Orinda Way, #D150 Orinda, CA 94563	Grant M. Inman (510) 253-1611	▲	14	21	20	32	43.5	Network Computing Devices, Viewstar, Unify
InterWest Partners 3000 Sand Hill Rd. #3-255 Menlo Park, CA 94025	Therese J. Kollerer (415) 854-8585	=	23	54	98	203	250	Cyrix, Radius, Stratacom
J.H. Whitney & Co. 630 Fifth Ave. #3200 New York, NY 10111	Michael Brooks (212) 757-0500	▲	20	50	50	120	400	Vitesse Semiconductor, Wellfleet Communications
JAFCO America Ventures 180 Maiden Ln., 21st fl. New York, NY 10038	Shoichi Fujikawa (212) 269-8900	▲	13	23	15	25	NA	Gensym, Microwave Module ar Devices, Netrix Systems
Kleiner Perkins Caufield & Byers 2200 Geng Rd., #205 Palo Alto, CA 94303	Floyd Kvamme (415) 424-1660	▲	100	150	350	450	500	GO, EO, Power Integrations
Lawrence, Tyrrell, Ortale & Smith 515 Madison Ave., 29th floor New York, NY 10022	Brian Horey (212) 826-9080	=	8	22	27	80	115	Centerline Software, On Technology, Tazarian
Marathon Venture Partners 388 Market St. #900 San Francisco, CA 94111	Thomas J. Bonomo (415) 989-1915	=	7	9	14	17	50	PEER Networks, IRIS Medical, Crosspoint Systems
Mass. Technology Development 131 State St. #215 Boston, MA 02109	Robert J. Crowley (617) 723-4920	=	25	31	7	8.5	13	Kronos, MicroTouch Systems, Voicetek
Mayfield Fund 2200 Sand Hill Rd. Menlo Park, CA 94025	Glenn M. Mueller (415) 854-5560	=	51	73	NA	370	NA	Aspect Telecommunications, MIPS Computer, Silicon Graphics
MDT Advisers 20 Acorn Park Cambridge, MA 02140	Schorr Berman (617) 864-5770	=	6	17	NA	40	NA	Anadigics, Wave Tracer, Cobotyx
Menlo Ventures 3000 Sand Hill Rd., #4-100 Menlo Park, CA 94025	DuBose Montgomery (415) 854-8540	▲	100	120	110	135	285	Frame Technology, Retix, Xyplex
Merrill, Pickard, Anderson & Eyre 2480 Sand Hill Rd. #200 Menlo Park, CA 94025	Steven L. Merrill (415) 854-8600	▲	54	61	96	103	285	Network Computing Devices, Synopsis, PictureTel
MK Global 2471 E. Bayshore Rd., #520 Palo Alto, CA 94303	Greg Lahann (415) 424-0151	=	17	22	53	60	65	Document Technologies, Netframe Systems, Proxim
Mohr, Davidow Ventures 3000 Sand Hill Rd. #1-240 Menlo Park, CA 94025	Lawrence G. Mohr (415) 854-7236	▲	29	34	34	41	71	Actel, Auspex Systems, Rambus

* ▲ expect to increase investment, ▼ decrease, = stay the same, NA = not available

VENTURE CAPITOL DIRECTORY

Company/Address	Contact/Phone	5-year outlook*	No. of companies funded		Investment ($ millions)		Total paid in capital ($ millions)	Some companies funded
			Electronics	Total	Electronics	Total		
Montgomery Bridge Funds 600 Montgomery St. #2100. San Francisco, CA 94111	John C. Siegler (415) 627-2039	=	25	40	68	95	100	MicroLinear, Metricom, Resound
Morgan, Holland Ventures One Libery Sq. Boston, MA 02109	Ed Kania (617) 423-1765	▲	20	30	40	65	100	Star Semiconductor, Dataware Technologies, Microwave Logic
Morgan Stanley & Co. 1251 Avenue of the Americas New York, NY 10020	Guy de Chazal (212) 703-4000	=	40	50	60	80	100	Ross Systems, Bachman Information, Sanmina
Morgenthaler Ventures 629 Euclid Ave. Cleveland, OH 44114	Theodore A. Laufik (216) 621-3070	=	14	42	32	75.8	160	Microchip Semiconductor, Vitesse Semiconductor, Synopsys
Nazem & Co. 600 Madison Ave., 14th fl. New York, NY 10022	Fred F. Nazem (212) 644-6433	▲	21	36	90	150	150	Mediavision, Spatial Technology, Momenta
New Enterprise Associates 1119 St. Paul St. Baltimore, MD 21202	Nancy Dorman (301) 244-0115	▲	108	169	163	254	394.2	Syquest Technology, Vitesse Semiconductor
Newtek Ventures 500 Washington St. #720 San Francisco, CA 94111	John E. Hall (415) 986-5711	▲	NA	NA	18	23	54	Logic Modeling, Spectralink, Caere
Norwest Venture Capital Management 222 S. Ninth St. Minneapolis, MN 55402	Promod Haque (612) 667-1650	▲	NA	NA	48	156	NA	Actel, Performance Semiconductor, Peoplesoft
Oak Investment Partners 3000 Sand Hill Rd. #3-240 Menlo Park, CA 94025	David P. Best (415) 854-8825	▲	37	69	269	324	495	Synopsys, Picturetel, Wellfleet Communications
Olympic Venture Partners 2420 Carillon Point Kirkland, WA 98033	George H. Clute (206) 889-9192	▲	16	22	NA	NA	70	Logic Automation, Triconex, Verity
Oxford Partners 1266 Main St. Stamford, CT 06902	William R. Lonergan (203) 964-0592	=	27	47	50	105	122	Vitesse Semiconductor, Zitel, Video/Phone
Paragon Venture Partners 3000 Sand Hill Rd. #2-190 Menlo Park, CA 94025	Robert F. Kibble (415) 854-8000	▲	12	26	32	42	70	Pages Software, Bimillennuim, Topomefrex
Partech International 101 California St. #3150 San Francisco, CA 94111	Vincent Worms (415) 788-2929	=	3	7	3	8	200	Ascend Communications, Biiosym Technologies
Pathfinder Venture Capital Funds 7300 Metro Blvd. #585 Minneapolis, MN 55435	Brian P. Johnson (612) 835-1121	▲	26	57	30	65	100	Digital Systems Intl., Confertech Intl., Optical Specialties
Poly Ventures Polytechnic University, Rt. 110 Farmingdale, NY 11735	Shelley A. Harrison (516) 249-4710	▲	5	15	NA	NA	53	None Supplied
Sequoia Capital 300 Sand Hill Rd. #4-280 Menlo Park, CA 94025	Donald T. Valentine (415) 854-3927	▲	120	200	NA	400	NA	Cisco Systems, Central Point Software, Auspex
Sevin Rosen Fund Two Galleria Tower #1670 13455 Noel Rd. Dallas, TX 75240	Jon Bayless (214) 702-1100	=	32	35	110	120	200	Videotelecom, Cyrix Semiconductor, Cyberonics

* ▲ expect to increase investment, ▼ decrease, = stay the same, NA = not available

VENTURE CAPITOL DIRECTORY

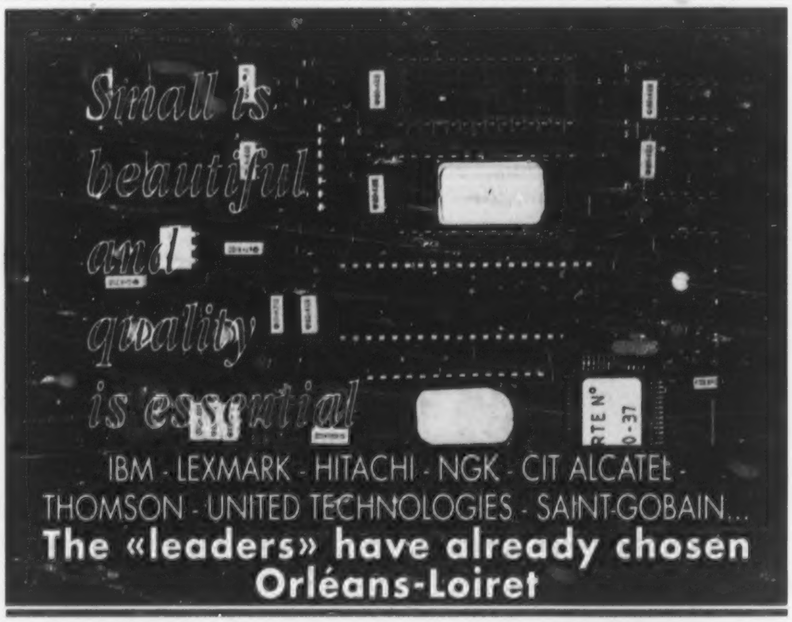
Company/Address	Contact/Phone	5-year outlook*	No. of companies funded		Investment ($ millions)		Total paid in capital ($ millions)	Some companies funded
			Electronics	Total	Electronics	Total		
Shaw Venture Partners 111 Southwest Fifth Ave. #2200 Portland, OR 97204	Alan S. Dishlip (503) 228-4884	▲	20	29	24	30	50	Protocol Systems, Aptix, Voxel
Sierra Ventures 3000 Sand Hill Rd. #4-210 Menlo Park, CA 94025	Vincent H. Tobkin (415) 854-1000	▲	40	60	NA	NA	160	Stratacom, Epoch Systems, Intuit
Sigma Partners 2884 Sand Hill Rd. #121 Menlo Park, CA 94025	Lawrence G. Finch (415) 854-1300	▲	42	44	65	70	120	Supermac Technology, Stac, Wellfleet Communications
Spectra Enterprises Associates 200 N. Westlake Blvd. #215 Westlake Village, CA 91362	James A. Cole (805) 373-8537	=	NA	17	NA	NA	NA	None Supplied
St. Paul Venture Capital 385 Washington St. St. Paul, MN 55102	Fredric R. Boswell (612) 223-2135	▲	20	50	100	300	NA	Tricord Systems, Broad Band Technologies, Cayman Systems
Summit Partners One Boston Place Boston, MA 02108	Karen Young (617) 742-5500	▲	26	56	42.2	68.6	675	Boca Research, Artisoft, McAffee Assoc.
Sutter Hill Ventures 755 Page Hill Rd. #A-200 Palo Alto, CA 94304	Paul M. Wythes (415) 493-5600	▲	10	45	NA	NA	NA	Edify, Forte, Aspect
TA Associates 45 Milk St. Boston, MA 02109	Stephen J. Gaal (617) 574-6700	=	46	70	250	325	500	Epoch Systems, BroadBand Technologies, Trident Microsystems
Technology Funding 2000 Alameda de las Pulgas San Mateo, CA 94403	David Titus (415) 345-2200	▲	15	30	100	200	260	Geoworks, Primary Access, Reflection Technology
Technology Venture Investors 2480 Sand Hill Rd., #101 Menlo Park, CA 94025	Mark G. Wilson (415) 854-7472	▲	NA	40	150	172	270	Synopsys, Farallan Computing, Intuit
Trinity Ventures 155 Bovet Rd. #660 San Mateo, CA 94402	Noel J. Fenton (415) 358-9700	=	20	36	27	49	76	Alldate, Answer, Wall Data
TVM Techno Venture Management 45 Milk St. Boston, MA 02109	Waldemar Jantz (617) 457-5251	▲	25	65	50	120	220	Digital Research, Netrix Systems, Keyfile
Vanguard Associates 525 University Ave. #600 Palo Alto, CA 94301	Jack M. Gill (415) 321-2900	▲	29	48	26	51	63	Tricord Systems, Topometrix, Databeam
Vencon Management 301 W. 53rd St. New York, NY 10019	Alina Fisch (212) 581-8787	▲	NA	NA	NA	NA	NA	None Supplied
Venrock Associates 30 Rockefeller Plaza #5508 New York, NY 10112	Peter O. Crisp (212) 649-5657	▲	30	50	NA	NA	NA	Echelon, Photon Dynamics, Photonics
Venture Capital Fund of New England 160 Federal St., 23rd fl. Boston, MA 02110	Kevin J. Dougherty (617) 439-4646	▲	17	31	13	24	48	Progress Software, New Media Graphics, Intra-Sonix
Venture First Associates 1400 Lake Hearn Dr. #205 Atlanta, GA 30319	J. Douglass Mullins (404) 843-5545	▲	5	30	NA	NA	NA	None Supplied

* ▲ expect to increase investment, ▼ decrease, = stay the same; NA = not available

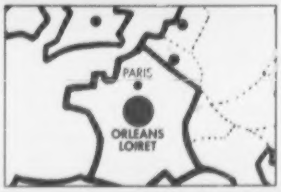
VENTURE CAPITOL DIRECTORY

Company/Address	Contact/Phone	5-year outlook*	No. of companies funded: Electronics	No. of companies funded: Total	Investment ($ millions): Electronics	Investment ($ millions): Total	Total paid in capital ($ millions)	Some companies funded
Venture Funding Group international 49 West 12th St., Executive Suite New York, NY 10011	Allan E. Skora (212) 691-9895	▲	10	12	NA	NA	NA	None Supplied
Walden Group 750 Battery St., 7th fl. San Francisco, CA 94111	Arthur S. Berliner (415) 391-7225	▲	33	50	25	100	150	Creative Technologies, RasterOps, S3
Weiss, Peck & Greer Venture Partners 555 California St., #4760 San Francisco, CA 94104	Philip Greer (415) 622-6864	=	22	50	49	133	225	Network Computing Devices, MicroLinear, Harmonic Lightwaves
Wind Point Partners 1525 Howe St. Racine, WI 53403	James Forrest (414) 631-4553	▲	8	50	18	104	126	Effective Management Systems, Climcom, CAD Information Systems
Woodside Fund 850 Woodside Dr. Woodside, CA 94062	Vincent M. Occhipinti (415) 368-5545	▲	12	16	11	15	30	None Supplied
Xerox Technology Ventures 101 Continental Blvd. #ESC1-110 El Segundo, CA 90245	Robert V. Adams (301) 333-2639	▲	6	11	15	30	25	Advanced Encryption Systems, Quiyote Products, Terabank Systems
Zero Stage Capital 101 Main Street Cambridge, MA 02142	Gordon B. Baty (617) 876-5355	▲	15	35	16	30	40	Swan Technologies, Mercury Computer Systems, Octocom Systems

* ▲ expect to increase investment, ▼ decrease, = stay the same, NA = not available


Small is
beautiful
and
quality
is essential
IBM - LEXMARK - HITACHI - NGK - CIT ALCATEL -
THOMSON - UNITED TECHNOLOGIES - SAINT-GOBAIN...
The «leaders» have already chosen
Orléans-Loiret

FOR MORE INFORMATION CONTACT :
Wendy Barbellion
International Trade Representative Orleans-Loiret
Hôtel de Ville, Place de l'Etape
45040 Orleans cedex 1, France
☎ (33) 38.42.27.29 - Fax (33) 38.42.07.83


PARIS
ORLEANS
LOIRET

Do something
to help America
prepare for
the future.

Support America's colleges. Because college is more than a place where young people are preparing for their future. It's where *America* — and American business — is preparing for *its* future.

Give to the college of your choice.

Ad Council A Public Service of This Publication

U.S. equipment vendors leverage IC know-how into LCDs

Sharp, Toshiba, and other companies seek help in improving their display yields, but some analysts warn against a "phantom market"

By Barbara Jorgensen

A handful of U.S. semiconductor equipment vendors may be the best bet for overcoming the yield problems plaguing makers of thin-film transistor (TFT) liquid crystal displays (LCDs), a market that is dominated by Japan. Some, including Applied Materials Inc., KLA Instruments Corp., and GenRad Inc. are developing LCD equipment at their Japanese customers' request—a move that augurs well for the U.S. equipment industry.

"That Japan is going to outside vendors indicates that their internal support structure cannot solve these problems," says Scott Young, technology director at Semiconductor Equipment and Materials International (SEMI), an equipment trade group. "They've learned the limitations of their [domestic] suppliers."

Companies such as Dainippon Screen, Nippon Mining Co., and Toshiba are even investing in Yankee ingenuity in hopes of improving their manufacture, test, and repair of TFT active-matrix (AM) displays. Japan is the only volume manufacturer of the displays, which require much of the same production technology as ICs (see chart).

Whether that's a long-term opportunity for U.S. vendors, however, is open to question. The low yields and economic slump in Japan have stalled the active-matrix display market—which Nomura Research Institute once predicted would reach $7.5 billion by 1995 but now pegs at $3.7 billion—and that has many industry analysts and vendors wondering when, if ever, the market will reach fruition. "We're surprised at how slowly these [yield] problems have been solved," says William Schneider, vice president of marketing and sales at MRS Technology Inc. in Chelmsford, Mass., which sold its first LCD-customized lithography machine in 1988. "The reason may be that we thought everyone could develop innovative technology quickly. But Japan does not have a tradition of quickly turning around innovative solutions."

Yields of usable TFT displays in Japan are now thought to run only 30% to 50%, resulting in displays priced between $1,200 and $1,500. The panel's size makes manufacturing-related lines, gaps, and dots highly visible on a lighted screen; a bad connection or short circuit renders a costly display useless. Current test methods determine that the panel works or doesn't. Japanese LCD manufacturers—the top tier includes Sharp, Toshiba, NEC, and Hitachi—are predictably closed-mouthed about their manufacturing limitations, but a recent report notes that one manufacturer's panels are beset by short circuits 38% of the time; by short circuits between layers 27% of the time; and by open circuits 13% of the time. Most failures are due to particles adhering to the devices.

Similarities in IC and TFT AMLCD production . . .

- Use of photolithography
- Intensive use of thin-film processing
- Requirement of large capital investment
- Use of fundamentally low-cost materials
- Process-intensive
- Manufacturing costs are highly yield dependent

. . . and how they differ

- TFT LCDs are made with one "chip" per wafer
- TFTs use much larger geometries
- TFT LCD substrate costs increase linearly with area
- TFTs require fewer mask steps
- TFTs have a smaller base of art and science
- TFTs afford no benefit of higher yield for smaller die dimensions
- Epitaxial layers are not possible

Source: Stanford Resources Inc.

For some U.S. equipment makers, a market stalled by manufacturing problems spells new business. "Many emerging markets exhibit the behavior that the LCD market has," says Bob Boehlke, CFO of KLA Instruments in San Jose. "There's a quick round of enthusiasm, then a retrenchment as yields are worked out, and then finally a rebound and growth period."

Still, once production problems are solved, one analyst thinks the new-equipment market will dry up. "It's a phantom market," Dan Hutcheson, president of VLSI Research Inc. in San Jose, says flatly. Drivers of the LCD equipment market, he explains, are not the invisible submicron line-widths and high integration of the IC market, but what is perceived by the human eye. Once gaps, shorts, and dots are eliminated, he explains, capital spending will be diverted to volume manufacturing equipment. Even a manager with Tokyo Electron Ltd. (TEL), which co-developed and sells an LCD test system with GenRad and distributes for Micrion Corp., agrees. "The market is probably one-tenth the size of the IC equipment market, and it won't grow like that market did. People will keep using the same equipment for a long time," says Kenji Washino, section chief of TEL's LCD group.

Others are advising caution at the very least. San Francisco-based Hambrecht & Quist's Carolyn Rogers says TFT LCDs are best approached as an extension to already established business, as with Applied Materials, which is spinning off a wholly owned subsidiary, Applied Display Technology (ADT), in Japan. "It's a good market to look at strategically, but flat panels *aren't* semiconductors," says Rogers. "In semis, materials aren't a big deal—but in panels, a lot of the cost is in materials." Rogers estimates the 1995 AMLCD equipment market could reach $700 million (see sidebar).

U.S. companies that are successfully penetrating the market are doing so through partnering or by bringing something new to the party. Santa Clara, Calif.-based Applied Materials, the recognized leader in clean chemical vapor deposition (CVD), is co-developing CVD equipment with LCD manufacturer Toshiba. Both San Jose-based Photon Dynamics Inc. and Peabody, Mass.-based Micrion have developed innovative repair systems.

Top LCD manufacturers

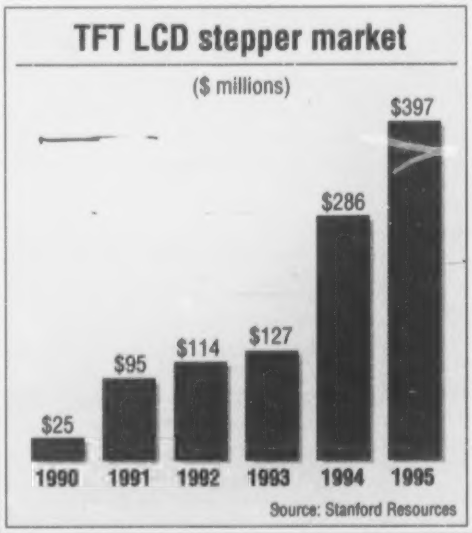
Sharp
Hitachi
Toshiba
Sanyo
Matsushita
Hosiden
NEC

Source: Hambrecht & Quist

Toshiba and Applied Materials will co-develop production systems in CVD, plasma etching, and physical vapor deposition that improve the process at the production end. The fact that Applied Materials has entered the TFT market confirms for some that the market clearly exists. Market watchers are quick to note, however, that LCDs will probably comprise only a small part of Applied Materials' overall business. "Applied had its reasons [for teaming up with Toshiba] beyond market size," says Hutcheson. "It's part of its overall strategy—even Applied is not that convinced it will be a big market."

"The LCD business is complementary to our core business," counters Norm Turner, managing director of ADT, "and those techniques are being employed in this new product development." Turner will not comment on whether its arrangement with Toshiba includes investment money. ADT expects to have initial CVD product on the market by the end of 1992. "We are well positioned to make the transition from IC equipment to TFT," adds Turner. "Japanese companies will go wherever they think they'll get a competitive advantage."

> **Once gaps, shorts, and dots are eliminated, capital spending will be diverted to volume manufacturing equipment**


TFT LCD stepper market

($ millions)

Source: Stanford Resources

Also vying for the front-end is MRS Technology, with possibly the largest installed base— "in the teens," allows Schneider—of any U.S. vendor of LCD equipment. Getting to market first so far has been a big advantage—Tokyo-based market research firm Global Net gives MRS Technology top share through '91 in LCD lithography. However, Canon and Nikon are catching up fast now that the market is, in theory, ramping up toward mass production, adds Global Net's director, Yasuhiko Takeno.

Although domestically there are no AMLCD fabs in volume production, MRS Technology has three lithography machines installed in the United States. One is at the David Sarnoff Laboratories in Princeton, N.J. Sarnoff has a "mini-fab" used for prototype development and R&D aimed at bringing AMLCD production on-shore. MRS's equipment is used to produce 14-inch AMLCDs—much larger than the 10-inch screens giving Japanese manufacturers trouble—says Arthur Firester, head of display applied research and development at Sarnoff. "This was the best machine for our purposes," he says, citing the equipment's scalability and flexibility of adapting to larger-size screens.

Firester points out that the equipment is not being used for mass production but adds, if it were, "we'd expect the reliability would be high and the costs low."

For in-process test, KLA Instruments and Nippon Mining formed a joint venture, KLA Acrotec, to manufacture inspection equipment. KLA Acrotec's 6000 inspection system does in-process digital-image processing of panels and can identify where in the process defects occur, allowing repair before final assembly. In such a partnership, Boehlke stresses the necessity of being close to the customer, particularly in a developing market. "Our customers are in Japan, so that's where we formed a joint venture," he says. "You have to be next to your customers and be ready to respond to their problems. [In inspection], we have a leading technology and our IC customers nearby, so we've been able to customize the product."

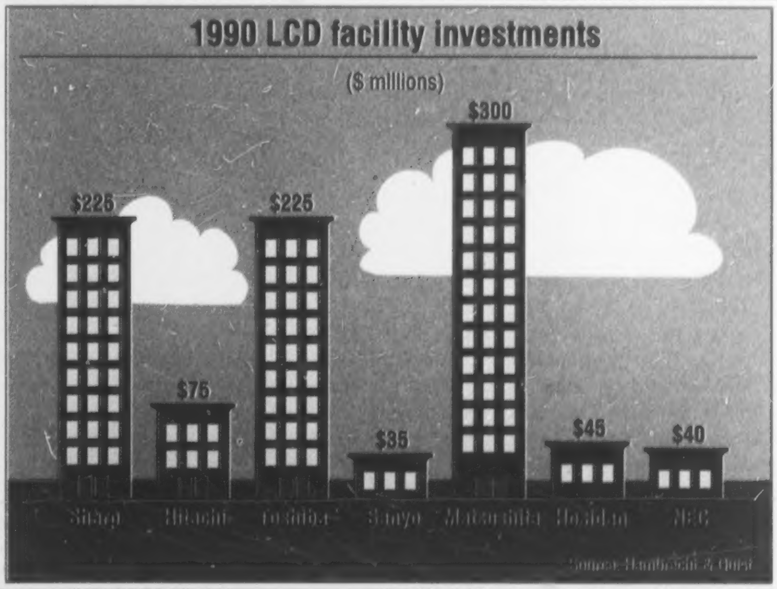
The next best thing to flawless lithography and deposition is in-process test and repair. Along with KLA, Photon Dynamics, Micrion, and GenRad have offerings in those areas. Only Photon Dynamics and Micrion, however, offer actual repair alternatives. Both companies have installed bases of six systems.

Nine-year-old Micrion, a manufacturer of ion-beam IC equipment for photomask repair and wafer process monitoring, began looking into leveraging that ability into LCD repair four years ago. The L1 Series uses a laser beam for both metal removal and low-temperature deposition to repair TFT displays. Micrion's L1 program manager, Richard Communale, sees LCDs as a natural expansion of Micrion's technology and customer base. "We've been dealing with Japan for a while," he says, "and if you don't do well there, you don't do well." Micrion does not have a major Japanese development partner or financial backer, but it does sell equipment through TEL. KLA is also an investor in Micrion.

Fast-rising Photon Dynamics has perhaps the only full-system solution for LCD inspection, test, and repair. Along with its voltage-imaging test system, Photon Dynamic's repair system uses a laser to deposit films or write metal lines on the LCD. President Francois Henley counts himself among the LCD market optimists, although all of Photon Dynamics' equipment can be used for other flat-panel displays. Photon Dynamics will be soon be expanding its product line to assembled panel inspection. "Panels have variations," says Henley, "in color and in hue. We can even establish grades of panels."

Even pessimists agree that the long-term potential for TFT displays is huge

The GenRad/TEL GTS-1 test-and-measurement system is capable of automated in-process substrate test and diagnosis through GenRad-developed software. Although customer feedback from Japan is notoriously sketchy and often confidential, TEL's Washino reports that eight of the largest Japanese LCD makers have expressed an interest in GenRad's tester. Still, he cautions, "There is a high probability that customers [in Japan] will choose the company that offers better service." Not coincidentally, this is what TEL does for U.S. companies. "They can't afford to have that whole expensive line down, and they most likely have no budget for repairs," Washino adds. "So you have to fix it for free and as soon as possible."


1990 LCD facility investments

Source: Hambrecht & Quist

"In a way, selling in Japan is easier because, once you establish the relationship, it doesn't matter so much if your machine's performance or price is a little worse," adds Washino. Maybe. There's still another aspect of selling in Japan that U.S. equipment makers are highly aware of, but have no fast solution. As Applied's Turner notes: "Nothing guarantees against reverse engineering."

MRS's Schneider says the only sure way creates another dilemma. "The only way to stop [eventual Japanese encroachment] is to stay one step ahead," he says. "But how do you fund that? It's a structural problem, especially in the United States. It cost us $18 million to get the first machine developed."

WILL JAPANESE VENDORS eventually replace the early U.S. innovators? "It depends on how well the U.S. responds and how well [vendors] control their intellectual property interest," says SEMI's Young. "I don't think it will follow the standard paradigm—the industry now is more capable of dealing with these issues" than it was in the 1980s.

"The other part of the equation," adds Young, "is whether the U.S. will develop and build display devices that will fuel local demand for equipment. That's an overall competitive issue—the U.S. has no indigenous display capability," which forces U.S. computer makers to source from many of their competitors. Optical Imaging Systems in Troy, Mich., makes AMLCDs for military consumption, and Xerox PARC in Palo Alto reportedly is researching AMLCD production.

Coming in July:

- Defense Electronics Report
- Customer Satisfaction Report

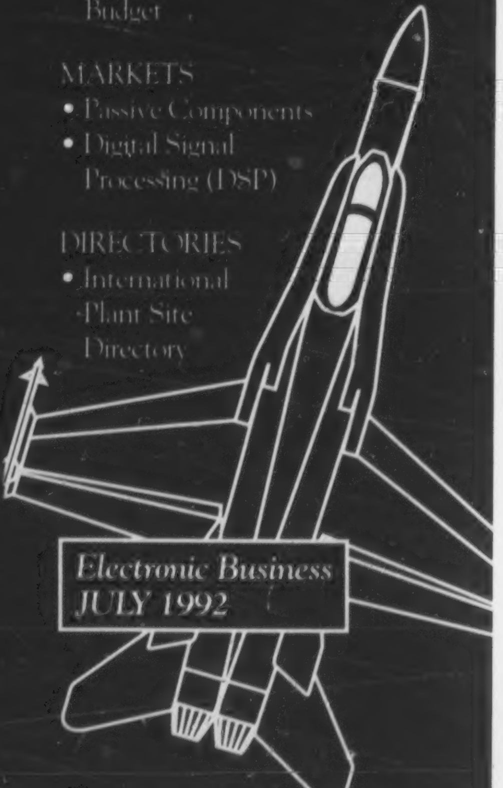
BUSINESS STRATEGY
- Defense Shakeout
- Defense Debate
- Customer Satisfaction

PRODUCT DEVELOPMENT & MANUFACTURING
- Commercializing Defense Research
- What's Hidden in DODs Labs
- Armed Forces Technology Snapshot

FINANCE & ECONOMICS
- Opportunities in the DOD Budget

MARKETS
- Passive Components
- Digital Signal Processing (DSP)

DIRECTORIES
- International Plant Site Directory



Electronic Business
JULY 1992

Electronic Business
For the Management Team in Electronics, Computer, and Systems Companies

Taking apart the numbers

ONE REASON ANALYSTS have difficulty projecting the AMLCD equipment market is that the LCD markets themselves have not developed the way even the Japanese anticipated. The yield problems have proved daunting, and the recession in Japan has slowed end-product sales and stalled capital investment.

Furthermore, the Japanese are closed-mouthed on their manufacturing problems, processes, and fabs. So, because of high pricing and problems with yields, even the panels' end-market values range from Nomura's optimistic $3.7 billion market (down from $7 billion) by 1995, to Stanford Resources' TFT LCD projection of $1.4 billion by that year.

The market for active-matrix LCDs hasn't taken off the way the Japanese expected

"I'm not convinced that cost will come down so quickly," says Stanford analyst Dave Mentley. "A whole array of manufacturing issues will first need to be resolved in order to hit these forecasts."

Nomura's equipment market forecast is by far the rosiest, and $1.5 billion (based on a $7 billion LCD market) most likely includes all AMLCD equipment, not just TFT. (AMLCDs can also be made by metal-insulated-metal and triple diode methods). Hambrecht & Quist uses the semiconductor industry model for its projections: Sales of capital equipment used by semiconductor manufacturers account for perhaps 10% of the sales of the devices themselves. So, basing estimates on a $7 billion AMLCD end-market from a number of published sources, Hambrecht & Quist arrives at a $700 million equipment market.

Two analysts use a typical AMLCD fab to model their projections. O'Mara and Associates in Palo Alto estimates an overall fab investment at $145 million to $150 million, including land and buildings, based on the glass substrate requirement of LCDs, analogous to silicon wafer starts in the IC industry. Stanford Resources, which specializes in the display market, uses a fab model projecting a total capital equipment investment for TFT LCDs at just over $110 million. Segments include photolithography, $42 million; deposition/etch, $45 million; inspection, $11 million; and the rest of the facility, $17 million. The model assumes panels are 8 by 10 inches, with more than 450,000 starts of TFT plates per year, at 50% yields. ☐

Even pessimists agree that the long-term potential for TFT displays is huge. Dave Mentley of display research firm Stanford Resources admits that Stanford has one of the most conservative forecasts for TFT LCDs but still anticipates a $4.5 billion market by 2000. Until manufacturing issues are resolved, however, even Japan's TEL prefers to be conservative regarding the equipment forecast.

"The LCD equipment market *does* have real growth potential, but it's not paradise," says Washino. "For five years," he concludes, "the market is bright. But in 10 years, it's a question mark."

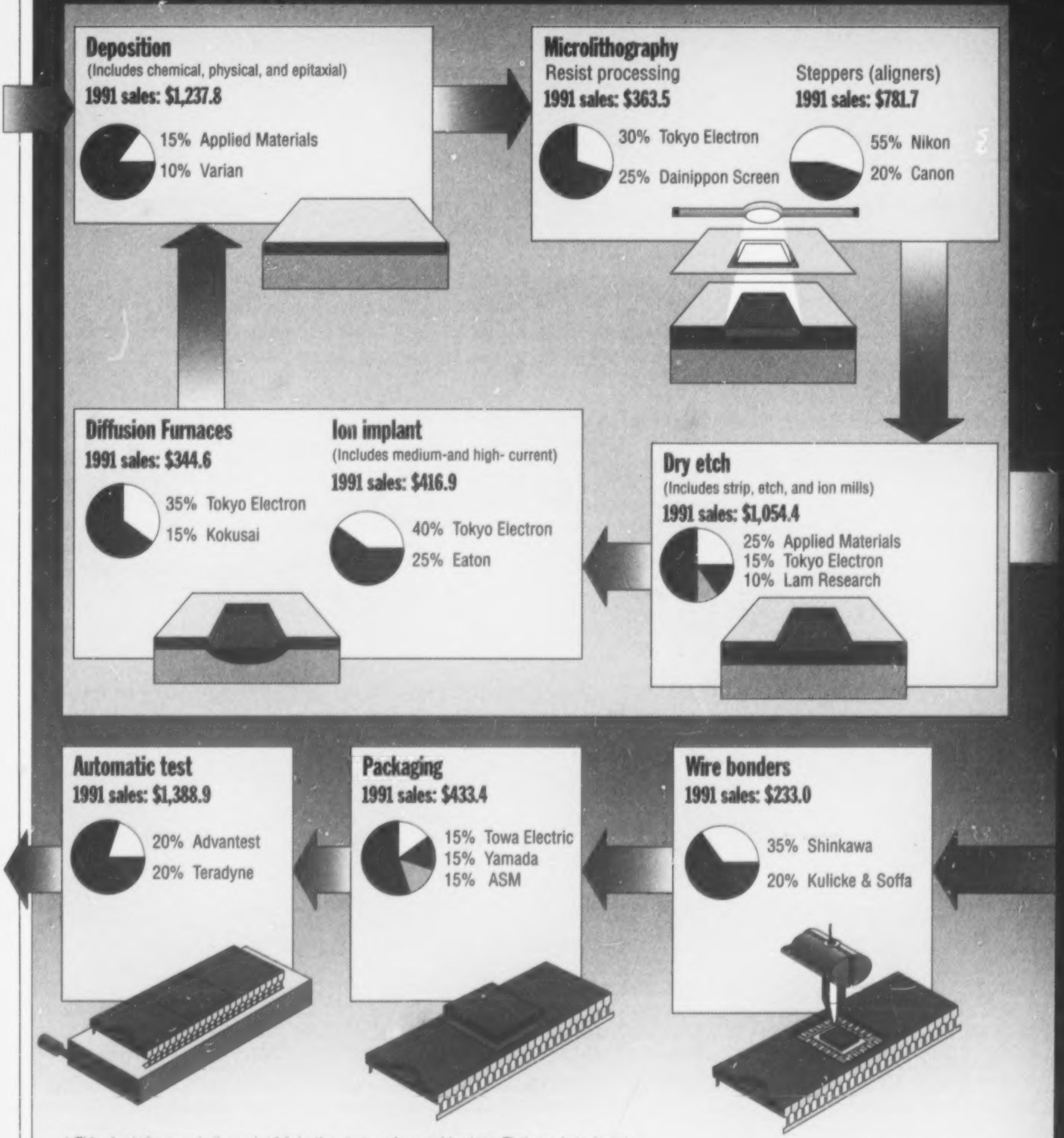
That said, many U.S. production equipment makers are preparing to enter the market. Those makers that are most likely to succeed in the long term are the companies that are attacking problems yet to be solved in the IC production world. Photon Dynamics, for example, is a good candidate to survive.

Paula Doe contributed to this report from Japan

Market snapshot:

Semiconductor manufacturing and inspection equipment

Worldwide calendar year 1991 sales ($ millions) and leading vendors' market share*



Deposition
(Includes chemical, physical, and epitaxial)
1991 sales: $1,237.8

15% Applied Materials
10% Varian

Microlithography

Resist processing
1991 sales: $363.5

30% Tokyo Electron
25% Dainippon Screen

Steppers (aligners)
1991 sales: $781.7

55% Nikon
20% Canon

Diffusion Furnaces
1991 sales: $344.6

35% Tokyo Electron
15% Kokusai

Ion implant
(Includes medium-and high- current)
1991 sales: $416.9

40% Tokyo Electron
25% Eaton

Dry etch
(Includes strip, etch, and ion mills)
1991 sales: $1,054.4

25% Applied Materials
15% Tokyo Electron
10% Lam Research

Automatic test
1991 sales: $1,388.9

20% Advantest
20% Teradyne

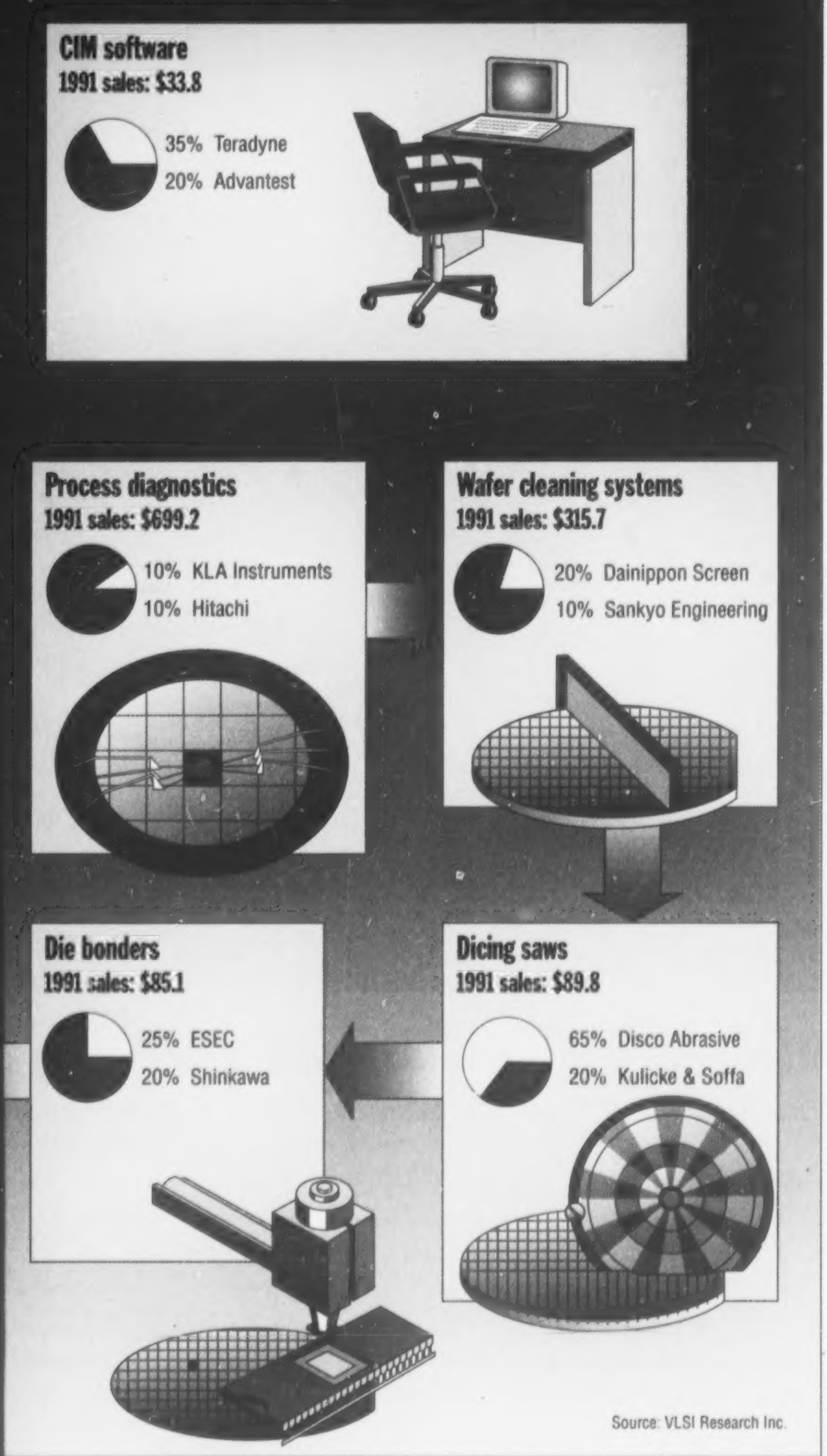
Packaging
1991 sales: $433.4

15% Towa Electric
15% Yamada
15% ASM

Wire bonders
1991 sales: $233.0

35% Shinkawa
20% Kulicke & Soffa

* This chart shows only the major fabrication, test, and assembly steps. Their markets do not add up to the total worldwide shipments. Market shares are rounded up to the nearest 5%.



Source: VLSI Research Inc.

Domestic equipment makers gained market share in '91

Nineteen ninety-one was a good year for U.S. manufacturers of semiconductor production equipment. Applied Materials Inc. rose a notch to replace Nikon as the world's No. 2 equipment supplier (after Tokyo Electron Ltd.), and U.S. companies' share of the global market rose to 40.8%, from 38% in 1990.

"This is a milestone for Sematech, which has been working closely with all of these U.S. companies to improve American manufacturing," says Dan Hutcheson, president of market research firm VLSI Research Inc. He reports that most of the U.S. gain came from Japanese competitors. The top-10 equipment manufacturers retained about 43% of the $9.9 billion worldwide equipment-and-services market.

The results are key indicators for the semiconductor equipment industry, notes Hutcheson, since they represent a shift away from lithography to chemical vapor deposition—Applied's and TEL's strength—as the dominant technology. Manufacturing issues are shifting from a focus on line-width to film deposition, diffusion, and sputtering.

—By Barbara Jorgensen

The top 10 equipment manufacturers

Company	Estimated sales* ($ millions)
1. **Tokyo Electric**	$764
2. **Applied Material**	654
3. **Nikon**	616
4. **Advantest**	448
5. **Canon**	360
6. **Varian**	328
7. **Hitachi**	316
8. **Teradyne**	263
9. **General Signal**	243
10. **Silicon Valley Group**	235

*1991 rank includes service and spares

Source: VLSI Research Inc.

Low-density MCU market remains robust, though less profitable

The electronification of just about everything keeps demand for 4-bit and 8-bit devices soaring

By Hugh G. Willett

The drive to distribute affordable intelligence in more new places will keep older 4-bit and 8-bit embedded control architectures alive through the end of the decade, according to experts, who point out that low prices and software compatibility are key to keeping the low end of the market growing.

Between 1989 and 1995, dollar sales of low-cost 4-bit and 8-bit devices will continue to grow at compounded annual rates of 1.6% and 13.5%, respectively, according to a study published by Electronic Trend Publications in Saratoga, Calif. At $5.4 billion, the combined 4-bit and 8-bit markets will still overshadow the $2.8 billion combined total of the 16-bit and 32-bit markets, the report shows.

"There's no doubt that the high end will offer the biggest growth in terms of average selling prices, but I expect to see positive sales growth in all the market areas for the rest of the decade," asserts Maryann Bader, consultant and author of the ETP report.

Designers are demanding more from existing architectures, driving the introduction of smaller controllers with more features and performance than many thought possible when the devices were introduced 10 or 15 years ago, Bader claims.

New applications in the automotive, industrial control, consumer, and home appliance markets continue to create opportunities for suppliers of 4-bit and 8-bit MCUs. Storage devices, communications equipment, and entertainment applications can make do quite well with 4-bit and 8-bit processors and controllers, where low cost is key to market acceptance.

At SMOS in San Jose, sales of 4-bit controllers are getting a boost from telephones that need low-end processing power for features such as caller ID, says Robert Wong, director of standard products. Other applications such as exercise machines will keep unit volume growing on these 4-bit devices for at least the next five years, he says.

"These are low-cost devices, probably no more than $4 each, but the volume runs into the millions," Wong says. "What we do is leverage our manufacturing relationship with Seiko Epson to keep costs down. We are making a profit on these chips."

Areas in which to add value at the 4-bit and 8-bit level include 3-volt operation

Amy Wasserman

and smaller, lower-cost packages, says Wong. As the chips move to Seiko Epson's 0.8-micron technology, power consumption will shrink, costs will drop even further, and performance will increase, adds Wong.

Unlike the traditional microprocessor markets, which quickly move on the next level of computing performance to make obsolete the earlier generations, there are a lot of good reasons to stick with an established embedded architecture for years, or even decades, says Jim Magill, vice president of business development at Zilog in Campbell, Calif.

SOFTWARE, PERFORMANCE, and system-cost reduction are the three most important factors driving the embedded markets, Magill says. All three factors can be addressed at the 8-bit level without moving up to 16-bit and 32-bit processors, for which new software must be developed and more expensive peripheral components purchased, he says.

On the performance and cost reduction side, 8-bit architectures have been able to advance through the integration of memory management units, clocks, and serial ports on the same chip. Magill points out that on-chip peripherals can increase performance and reduce overall systems costs.

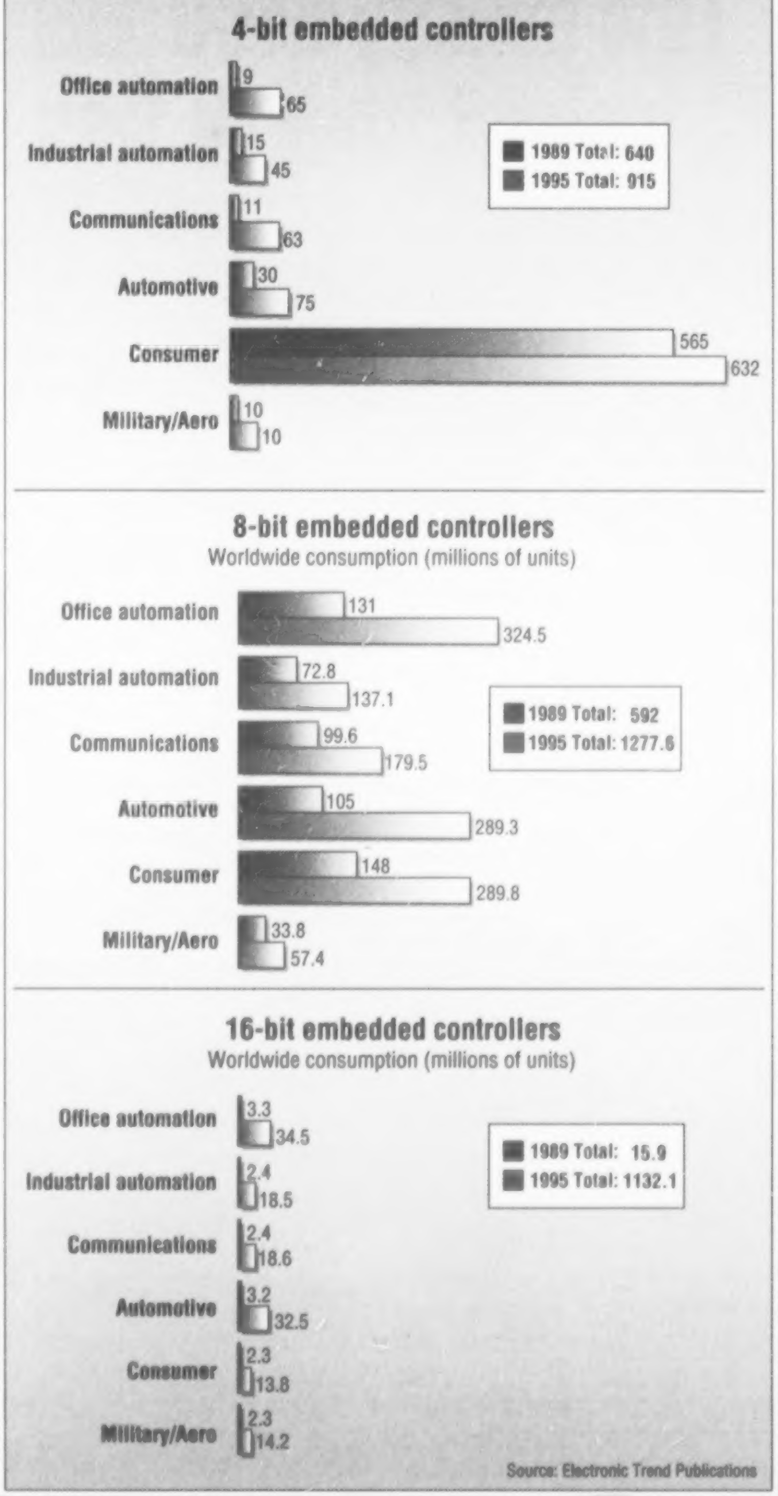
NEC Corp. also has a line of 4-bit controllers that can be configured with on-chip peripherals, including analog-to-digital converters and drivers for fluorescent displays, to save space, lower the cost, and increase performance. The controller chips are considered "semi-intelligent" and can be programmed for a variety of applications, says Marty Stolz, product marketing engineer at NEC.

"They find their best use in applications that require a bright vacuum fluorescent display with many digits and segments," he says. "The most common applications are in the consumer electronics and appliance industries."

Another way to increase the performance of 8-bit microcontrollers is

How embedded processor demand is shifting

Worldwide consumption (millions of units)



Source: Electronic Trend Publications

Performance drives sales of high-end embedded processors

SALES OF 32-bit embedded processors aren't about to match those of the low-end microcontrollers, but high average selling prices make the market an attractive niche for microprocessor vendors reeling from the confusion and competition in the desktop computer markets.

Battles for the desktop have left some MPU heavyweights searching for homes for their rejected products. Motorola, for example, never quite got its 32-bit RISC-based 88000 off the ground in the desktop market, but it jumped at the chance to position the chip as an embedded processor when Ford Motor Co. expressed interest in the chip for engine control in future generations of automobiles. Whether the Ford "design win" will save the 88000 isn't yet clear, but the episode illustrates how dependent these 32-bit chips can be on a single customer for survival.

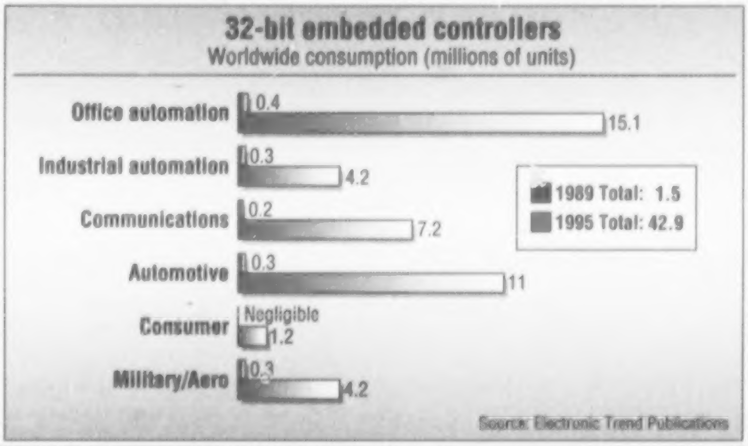
Despite the low-cost bias of all embedded processors, performance is still driving many applications, says analyst Maryann Bader. The laser printers' endless appetite for speed is rapidly outstripping the processing ability of more general-purpose 32-bit architectures such as Motorola's 68000, and they now need SPARC and MIPS-based RISC performance, she says.

That need has also created a window for Advanced Micro Devices, National Semiconductor, and Intel—all of which have had trouble establishing their RISC offerings as computer engines but have had more success in winning designs as printer and graphics controllers.

Originally targeted at the desktop workstation market, SPARC and MIPS processors have also managed to benefit from the fragmenting market. They can often provide better performance per dollar than high-end microprocessors such as Intel's 486 and Motorola's 68040, says Brian Halla, vice president of LSI Logic's Microprocessor Group. RISC designs use less silicon, making them more cost-effective to produce and leaving room on the silicon for additional features, he says.

RISC designs use less silicon, so they're more cost-effective and have room on the silicon for additional features

LSI Logic is offering what Halla jokingly refers to as a "Mr. Potato Head" service, allowing customers to mix and match an assortment of peripherals around the core processor in a manner similar to the way children configure the toy spudman with a variety of appendages. LSI Logic is using its application-specific IC technology to configure custom logic, memory, and peripheral functions around its SPARC and MIPS-based RISC cores for a powerful single-chip solution to laser printer engines and embedded processing applications such as industrial control.


32-bit embedded controllers
Worldwide consumption (millions of units)

Source: Electronic Trend Publications

VLSI Technology, using its 32-bit RISC-based ARM core processor, is also offering a cell-based ASIC solution that integrates custom functions around the core processor for embedded solutions. Again, the key to RISC is its efficient utilization of silicon, which gives a powerful solution at the low cost needed for embedded applications.

ANOTHER OPPORTUNITY for U.S. suppliers is the increasing use of digital-signal processing (DSP) for embedded control. Developed for military applications, DSP uses software algorithms in silicon to manipulate digital signals quickly and easily for interface with real-world analog inputs.

"DSP provides more performance for the buck compared with high-cost RISC processors," says Arie Brisch, marketing manager at Motorola. "DSP can perform more functions on a single chip."

Companies such as Motorola and Texas Instruments are applying volume efficiencies to their DSP designs to bring the costs down to the level needed for various applications including those that control large arrays of disk drives. Because DSP provides a lot of software functionality in silicon, overall system costs can be reduced.

Star Semiconductor is also looking to make its name in DSP for commercial applications. Star's edge is its proprietary software, which quickly tunes Star's DSP processors for specific applications without the expensive development effort usually required of DSP designs, says Bob Patterson, vice president of marketing at the Warren, N.J.-based company. ☐

8-bit embedded controllers have lots of life left

Worldwide revenue ($ millions)

	1991	1992	1993	1994	1995	6-year CAGR*
4-bit	$739.5	$782.6	$736.9	$761.3	$775.5	1.6%
8-bit	2,942.2	3,370.5	3,864.8	4,323.7	4,658.7	13.5
16-bit	435.6	566.8	741.9	890.9	994.3	32.3
32-bit	440.9	737.8	1,121.9	1,445.5	1,846.5	45.1
Total	4,558.2	5,457.7	6,492.5	7,421.4	8,275.0	16.7

* Compounded annual growth rate

Source: Electronic Trend Publication

to use the RISC techniques common among 32-bit processors and apply them to the low-end devices. Microchip Technology has developed a line of 8-bit controllers that produce 5-MIPS performance at a cost of about $5 each in volumes of 1,000.

Microchip Technology's PIC line can operate with 200-nanosecond cycle times to provide performance previously unheard of at the 8-bit level, says Ernest Vilicana, director of marketing at the Chandler, Ariz.-based company. Microchip Technology can convert logic equations of multiple programmable logic arrays into a single high-speed controller-based solution that will save space and cost while increasing performance, he says.

Venerable architectures such as Zilog's Z-80 and Motorola's 68000 have become standards, serving as educational exercises for student engineers who have become comfortable writing software to control the processors and designing interfaces for everything from hard-disk controllers to microwave ovens.

"Who would've thought that an architecture like the Z-80 would last for 15 or 20 years?" Magill muses. "We have been able to increase the performance and lower the cost while simultaneously offering designers a software environment with which they're very familiar." According to Magill, 70% to 80% of an embedded-control customer's investment is in software.

Software development is just as important to the embedded-control customer as hardware performance, confirms Jerry Kirk, president and founder of Microtec Research, a Santa Clara, Calif.-based developer of compilers and debuggers for embedded processing. Writing better code for 4-bit and 8-bit devices can result in higher performance from the same software, he says.

"The most powerful processors often require the most complex software support, but at all levels of performance, quality software and time to market are important," Kirk says. Microtec has made a business out of providing optimized support for standard processors that allows OEMs to add embedded intelligence to their products within tight design cycles.

Hard-disk drives are one fast-growing embedded application in which software support solves technical and marketing problems, Kirk says. Although 8-bit processing power may be sufficient, the sophisticated analog interface needed requires advanced software and debugging to assure a bug-free drive meets narrow market windows, he adds.

Jerry Kirk, president and founder of Microtec Research

Interestingly enough, software has sparked an interest in DOS compatible 8-bit microprocessors for embedded applications, according to Chips and Technologies, which late last year introduced a single chip PC based on Intel's venerable 8086 processor. Originally targeted at the hand-held computer market, PCchip is finding more acceptance as an embedded processor in applications where DOS compatibility is important.

AN IMPORTANT FEATURE for embedded controller targeted at application-specific niches is the need for user configurability. Hitachi, one of the largest producers of low-end microcontrollers, offers its zero turnaround time ZTAT features on almost all its microcontrollers. ZTAT uses field-programmable read-only memory (ROM) to allow the customer to configure the standard microcontroller for special functions.

Zilog, which also offers configurable memory on its controllers, is taking another tack to provide custom embedded-control solutions. A new 8-bit device from the company offers programmable output drive capability that allows the designer to tune the processors' output to reduce electromagnetic interference by as much as 75%, Magill says.

Zilog's plans for custom solutions will be supported by new investments in ASIC technology and manpower. In April, the company announced that it acquired the assets of Avant Inc., a communications chip design house that Zilog has used in the past to develop custom chips. Bringing the ASIC design resources inside Zilog will make it even easier to configure low-cost, high-performance custom microcontrollers, says Edgar Sack, president and CEO of Zilog. □

BUSINESS STAFF

Publisher's Office
Frank J. Burge, Vice President, Publisher; Mary Brodeur, Assistant to the Publisher; David C. Ciommo, Financial Director (Boston); Carla Koster, Contracts Coordinator; Robert Stewart, Director of Research; Jim McLeod-Warrick, Group Research Manager: Cahners Building, 275 Washington Street, Newton, MA 02158 (617) 964-3030

SALES STAFF

CT, MA, ME, NH, NY state, Long Island, RI, VT, eastern Canada
Ron Mastro, Regional Manager: 199 Wells Avenue, Newton, MA 02159 (617) 964-3730

AL, DC, DE, FL, GA, NC, NJ, PA, SC, VA, WV, New York City
John Maher, Regional Manager: 487 Devon Park Drive, Suite 206, Wayne, PA 19087
(215) 293-1212

AR, IA, IL, IN, KS, KY, LA, MI, MN, MO, MS, ND, NE, OH, OK, SD., TN, TX, WI
Susan Parziale, Regional Manager: Cahners Plaza, 1350 E. Touhy Avenue, P.O. Box 5080,
Des Plaines, IL 60018 (708) 390-2984

AZ, CO, NM, UT
John Huff, Regional Manager: 44 Cook Street, Denver, CO 80206 (303) 388-4511

Bay Area, Orange County, San Diego, OR, WA, UT
Mark Alden, Regional Manager: South Bay Office Tower, 3031 Tisch Way, Suite 100, San Jose, CA 95128 (408) 243-8838

Market development
Annie Foley, Manager: 275 Washington Street, Newton, MA 02158 (617) 558-4698

Bay Area, Los Angeles, San Fernando Valley
Chuck Signor, Regional Manager: South Bay Office Tower, 3031 Tisch Way, Suite 100, San Jose, CA 95128 (408) 243-8838

Mail list rental
Cahners Direct Marketing, 1-800-537-7930
Department: Cahners Plaza, 1350 E. Touhy Avenue, Des Plaines, IL 60018 (708) 635-8800

WORLDWIDE SALES STAFF

European Office
Electronic Business, 27 Paul Street, London EC2A4JU, England. Telephone: 011-4471-628-7030, Telex: 914911 CAHNE G FAX: 011-4471-628-5984

France and Belgium: Laura Whiteman: 14 Rue des Parisiens, 92600 Asnieres-Sur-Seine France
Telephone: 011-33-1-4790-0507
Fax: 011-33-1-4790-0643

Scandinavia: Stuart Smith, 27 Paul Street, London

Germany: Karin Steinbacher: New Media Munchen, Ismaninger Strasse 108, 8000 Munich 80 Germany
Telephone: 011-49-8998-5135
Fax: 011-49-8998-0117
Franz X. Fleischmann
Mediapac, Hanaver Landstrasse 294, D-6000 Frankfurt/Main 1, Germany
Telephone: 011-49-69-42-29-51
Fax: 011-49-69-42-12-88

Austria and Switzerland: Exportwerrbung AG, Kirchgasse 50, 8024 Zurich 1, Switzerland
Telephone: 41 1 261 46 90 Fax: 41 1 251 45 42

Israel: Asa Talbar: Adin Talbar: Adin Talbar and Associates, P.O. Box 22917, Tel Aviv 61228, Israel
Telephone: 972-3-223-621 (972-2-228083),
FAX: 972-2-247403

Japan: Kaoru Hara: Dynaco International Inc., Suite 1003, Sun-Palace Shinjuku, 8-12-1 Nishishinjuku, Shinjuku-ku, Tokyo 160, Japan
Telephone: 03-366-8301, Telex: 781 J2322609 DYNACO

Republic of China (Taiwan): Parson Lee: Acteam Int'l Marketing Corp., 2 Fl.No.17, Alley 7, Lane 217, Sec. 3, Chung Hsaio E. Rd., Taipei, Taiwan R.O.C. Telephone: 02-711-4833 Telex: 29809 ACTEAM, FAX: 886-2-7415110

Singapore: Hoo Siew Sai: Major Media Pte Ltd. 6th fl. 52 Chin Swee Road, Singapore 0316
Telehone: 011-65-738-0122
Fax: 011-65-738-2108

MY VIEW

Customer Delight. TQL and TQC

AT THE RECENT ELECTRO show in Boston, I had dinner with a gent from a midwestern electronics company. We had first met a little over two years ago when his company had just launched a Total Quality Management (TQM) program. He described for me with a great sense of pride the employees' suggestions that had led to over $400,000 in savings in the first year of the program alone. People at all levels in the organization had taken on the challenge of improving not only the quality of the product but the quality of the relationship with the customer. They had developed a real sense of working together to improve quality, trim costs, and delight customers. And they were able to achieve a real sense of accomplishment. Near the end of our dinner, I asked what lessons he had learned from the experience. There were many, he said. First, he had the absolute conviction that people would respond to the Total Quality challenge if they had leadership from the top and, equally important, leadership from middle management. Cynical middle managers can scuttle even the best-conceived program; leaders can make it happen. Leaders at all levels in the organization. TQL, not TQM. Leadership, not management.

The second lesson he learned was that, given the opportunity to participate in the process, people will rise to the occasion. And, he smiled and observed, "It's just more fun coming to work. We all get lots of positive feedback from management, from each other, and particularly from the field sales folks and customers. Market share, sales, and profits are up." Fun, indeed.

The next day, I had tea with a marketing friend whose company had been one of the early adopters of the practice of Total Quality and a two-time Baldrige entrant. As I described my experience from the night before, he interrupted and shoved a letter into my hand from one of his company's major customers. It set down a brief list of demands that had to be met if my friend's company expected to do business with this customer in the future. In a nutshell, the deal was this: Cut your prices 10%, or take a hike.

My friend was furious. For over five years, his company had worked to help design products with the customer. Worked together evenings and more than a few weekends to help this customer become successful. And what did have to show for it? A form letter demanding a 10% price reduction.

My friend's experience may be an exception to all the talk we hear about supplier and customer partnerships, but I don't think so. There are still plenty of opportunists out there who will milk the supplier relationship for all it's worth and then sell a supplier down the river for a dime.

It's time we launched a TQC program. TQC—for Total Quality Customer.

—Frank Burge, publisher

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.**
ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA.
Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

How to reap the riches of the DOD laboratories
PAGE 61

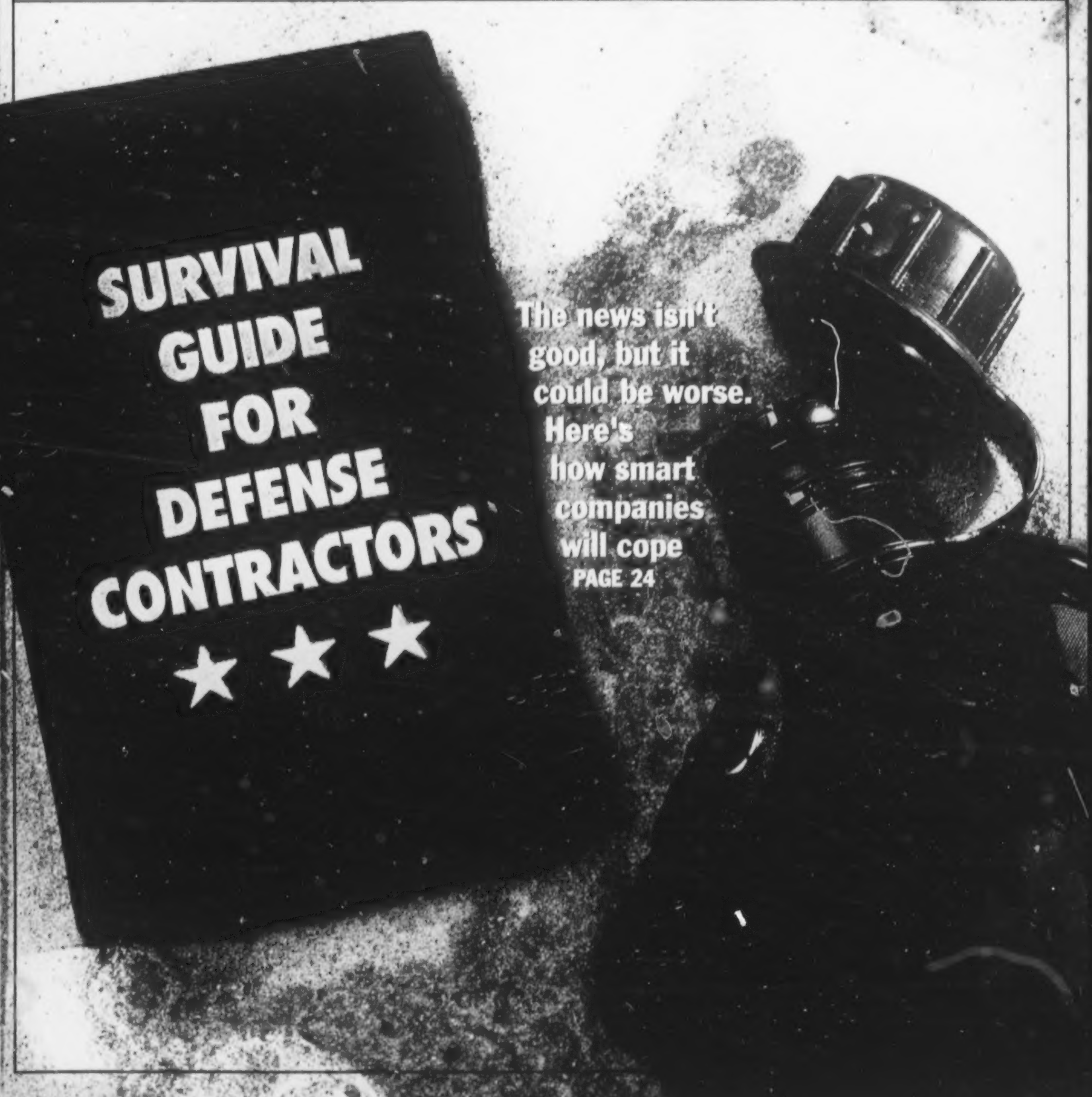
Strategies for dodging the defense-budget ax
PAGE 67

Service is key to success for capacitor vendors
PAGE 100

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE
JULY 1992



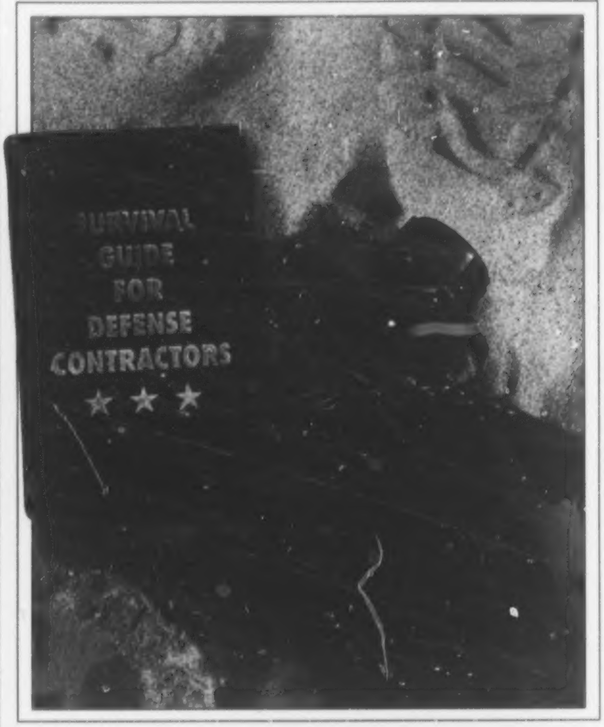
SURVIVAL GUIDE FOR DEFENSE CONTRACTORS

★ ★ ★

The news isn't good, but it could be worse. Here's how smart companies will cope
PAGE 24

Electronic Business

VOLUME 18, NUMBER 10
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE
JULY 1992



COVER STORY

PRODUCT DEVELOPMENT & MANUFACTURING

24 **Defense electronics: A survival guide**

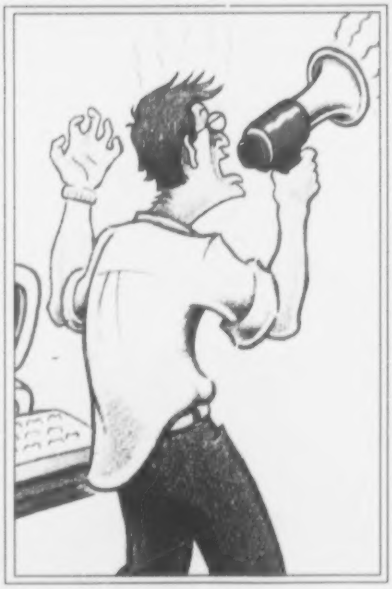
Since the shakeout in the defense electronics industry, many the little guys have found themselves outside of the protective covering of the Pentagon's wing. While there is no easy escape, one clear lesson has emerged for those looking for direction: Don't stand still

Cover photograph by Dave Bradley

UPFRONT

Business Trends

7 Customer complaints are an untapped source for product ideas; Selling abroad gets tougher; Digital to challenge analog in cordless phone market; Japan to rebound quickly as appetite for chips grows; U.S. software breaks down Japan's PC market barriers



PAGE 7 Customer complaints are finally being heard

Business Barometer

19 **Electronic components**
Component industry recovery begins, despite orders blip

19 **Instruments & ATE**
Higher productivity needs drive measure & control sales

20 **Leading Indicator**
Indicator back on track this past May

PAGE 67 Customer satisfaction program pays off for Quickturn

PAGE 52 Dr. William H. Hunsinger speaks out about dual-use

PAGE 61 Harry Diamond Labs' Mary Binseel agrees cooperation and communication between government and industry is increasing

FEATURES

PRODUCT DEVELOPMENT & MANUFACTURING

52 **Dual-use. What is it, and how can you make it work?**
Turning defense dollars into commercial product is a bear. Obtaining buy-in from the DOD and dollars from commercial investors are two big hurdles

61 **How to uncover some of the Pentagon's best-kept secrets**
Industry and DOD labs may finally have something in common—trying to make a profit

FINANCE & ECONOMICS

67 **Why the DOD budget isn't all gloom and doom**
It's falling like a rock, but smart companies still have a few opportunities to get a piece of a $38 billion pie

BUSINESS STRATEGY

73 **Quickturn's customer-satisfaction program pays off in repeat sales**
Users of the company's chip-verification tools have the final word on whether their needs are being met

INTERNATIONAL

86 **International plant sites directory**
Here is our 1992 directory for how to grow your business in North America, South America, Europe, Asia, and the Middle East

MARKETS

100 **Customers reap rewards of competitive capacitor market**
Manufacturers see little market growth, but they strive to maintain—and gain—customers through service

106 **Hot DSP market tantalizes analog and digital IC makers**
Both see gold in growing demand from communications, imaging, and graphics applications. Figuring out which niche to serve is the immediate challenge

DEPARTMENTS

My View *By Frank Burge, publisher*

111 On Wisconsin

Company Index

112 Companies covered in this issue

Advertiser Index

112 Advertisers covered in this issue

Viewpoint *By John Russell, editor*

114 O'Brien's theorem: Start small, work fast, and do it yourself

PRODUCT DEVELOPMENT

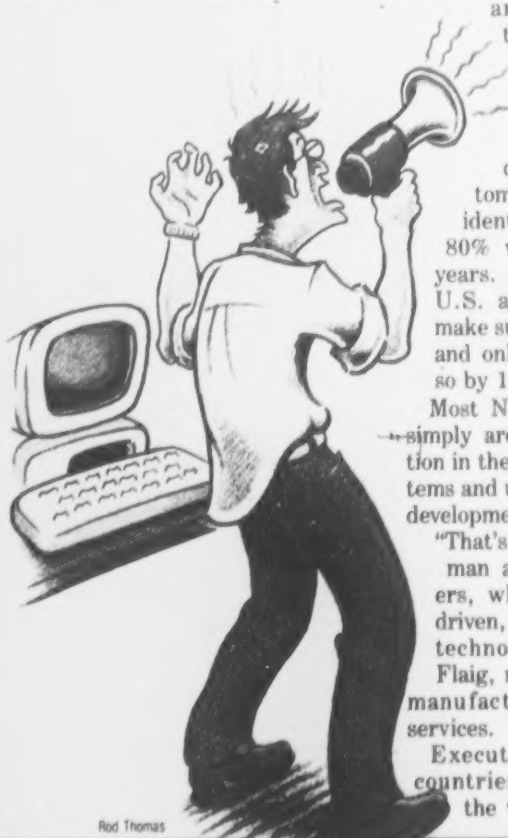
Customer complaints are an untapped source for product ideas

By failing to channel customer complaints into new product development, U.S. computer companies are missing important opportunities to improve their products. What makes this bad news even worse is that German and Japanese execs are far more likely to use criticism as input to product development operations.

These are the key findings of a survey of 116 computer and peripherals companies in the U.S., Canada, Japan, and Germany conducted by the Ernst & Young professional services firm and the American Quality Foundation, a New York-based think tank. The survey examined the companies' quality management techniques that existed three years ago, those practiced today, and what is planned for three years from now.

The results weren't all bad. Forty-five percent of all surveyed executives said that in the past, customers "usually" or "always" played a prominent role in identifying new product opportunities. Today 64% of the surveyed companies involve customers in product development and 77% plan to do so in the future.

Here's a sampling of what customers are learning from complaints: Several midrange computer makers discovered their customers wanted diagnostic capabilities built into the computers for predicting system failures. Other vendors redesigned their computers to more easily accommodate third-party products after scrutinizing customer gripes.



Rod Thomas

U.S. and Canadian execs, though, are slower than some of their counterparts in mining customer complaints for new product ideas. A majority of German and Japanese computer companies now use customer complaint systems for identifying new products; fully 80% will do so within three years. Only about a quarter of U.S. and Canadian companies make such use of customer gripes, and only 40% to 50% plan to do so by 1995.

Most North American companies simply are not taking the information in their customer complaint systems and using it as input to product development, concludes the report. "That's because unlike and German and Japanese manufacturers, which are more customer-driven, U.S. companies are more technology-driven," says Scott Flaig, national director of E&Y's manufacturing/high technology services.

Executives from all four countries also fail to recognize the value of suppliers in product development. The number that "always or almost always" involve their suppliers is a measly 2% or 3% and little is expected to change in three years. "These companies may be missing an important opportunity to strengthen their supplier relationships and hear a fresh perspective on new product ideas," the report concludes.

Customer visits are also favorite strategies for developing new product ideas, the survey found, and benchmarking the product development operations of "best-in-class" companies will be practiced by more than 50% of the respondents by 1995.

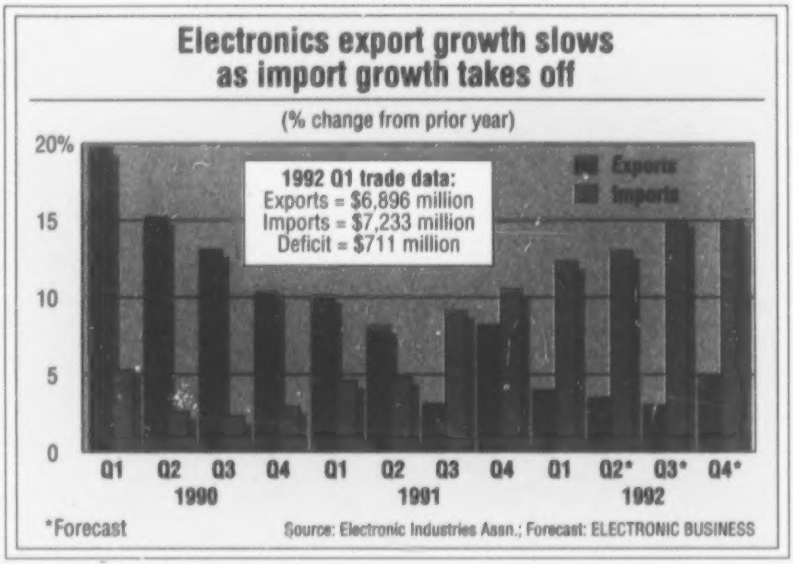
—*Rick Whiting*

TRADE

Selling abroad gets tougher and trade deficit gets worse

Don't count on '92 exports to make a dent in the U.S. electronics industry's trade deficit with the world. Although the deficit improved in the first quarter from late-1991 levels, it worsened significantly from year-ago levels—and that's likely to continue.

U.S. dependence last year on exports makes this year's projected



Electronics export growth slows as import growth takes off

(% change from prior year)

*Forecast

Source: Electronic Industries Assn.; Forecast: ELECTRONIC BUSINESS

slowdown more frightening. In 1991, U.S. factory production of electronic equipment and components grew just 1.7% while exports surged 12.1%. Expect production growth to double this year—still not great—as the U.S. economy revives from its recession. Still, export growth will be cut 6% or less as world economic growth falters.

Recent data from the Electronic Industries Association show the U.S. electronics trade deficit totaled $711 million in the first quarter of 1992. That's down from a $2.8 billion deficit in the previous quarter, but a reversal from a *positive* $701 million trade balance in the first three months of last year. The deficit in early 1992 was caused partly by a surge of electronics imported into the U.S.: imports grew 12.3% in the first quarter of the year, up from 4.6% growth in the first quarter of 1991. In contrast, over the same time period, exports slowed to 4% growth from 10.1% growth the year before.

Global economic growth was weaker than expected in 1991 and likely will remain slow in 1992, dimming prospects for rebounding exports. Economists at the International Monetary Fund (IMF) report world output fell 0.3% in 1991 and will grow only 1.4% in 1992. Japan's growth will slow from 4.5% last year to 2.2%, pressuring Japanese manufacturers to export more to the U.S.

The European economy grew 0.8% last year and will increase 1.8% this year. Leading indicators show a "global business cycle stuck in neutral," says Geoffrey Moore of the Center for International Business Cycle Research at Columbia University.

The end result of the export slowdown may be more protectionism. The trend worldwide: Antidumping investigations rose from 96 in 1990 to 175 in 1991.

—E. B. Baatz

TELECOMMUNICATIONS

Digital to challenge analog in cordless phone market

Despite a variety of problems that include less secure lines and erratic performance, about 9 million analog cordless phones will be sold in the U.S. this year—that's a $707 million market, according to the North American Telecommunications Association. Now, a deal between Teknekron Communications in Berkeley, Calif., and communications equipment maker Taihan Electric Wire Co. in Seoul, promises to bring digital technology to the residential cordless market for the first time.

Digital cordless phones could solve the privacy and performance shortcomings of their analog competitors. Teknekron's technology employs a scheme called code division multiple access (CDMA), which spreads digitized voice transmissions across several frequencies, making them difficult to tap, and gives them extra immunity from noise.

"The biggest challenge is how to bring the cost of the technology down, and our solution to that is to permit the manufacture of large unit quantities," says Edward Chien, executive director of personal communications systems for Teknekron. The phone's price should be competitive with high-end analog phones, which retail for $300 to $400.

Establishing a common design spec is the key to succeeding with digital cordless for home use. There is currently no industry-standard spec. Teknekron is promoting its own Digital Cordless Phone (DCP) systems spec, and has licensed the spec to a number of major analog phone vendors. Chien won't name the vendors, but claims the licensees account for about half of the current market.

Chien says Teknekron's phone can also serve in business environments and within future "personal communications networks" (PCNs). PCN proponents envision a public infrastructure consisting of receiving stations that can accept pay calls from cordless phones that people carry with them at all times.

Teknekron won't be the first to bring CDMA phones to the business and PCN worlds, though. Omnipoint of Colorado Springs currently sells a CDMA-based phone for corporate systems and expects to sell digital cordless phones into maiden PCNs by this fall. Chien argues that the large home cordless market will be the best springboard into the PCN environment.

At least one industry observer, Forward Concepts' president Will Strauss, doesn't discount Teknekron's cordless-to-PCN scenario. "I wasn't expecting any digital cordless phone activity in the residential market for another year, and was really surprised when Teknekron announced its deal with Taihan," he says. "This will get Teknekron a lot of respect."

—Dwight Davis in Seattle

INTERNATIONAL

Japan to rebound quickly as appetite for chips grows

Sluggish times notwithstanding, Japanese pundits expect semiconductor demand in that country will soon rebound and grow faster than in the rest of the world. That's a clear signal to U.S. chip vendors not to ease up efforts to penetrate that market.

Japanese electronics manufacturers remain remarkably optimistic. Components makers such as Alps, TDK, and SMK claim orders are picking up for components to go into exported goods—particularly PCs and consumer goods bound for the U.S. Most major electronics manufacturers claim orders bottomed out in February and are on the way back up for two main reasons: Exports to the recovering U.S. market are on the rise, and companies are finally working off their inventories.

Here's what Japan will buy in 1995

Semiconductor demand by market segment

Semiconductors for:	**1995 demand** ($ millions)	**Annual growth average** 1989-1995
Computers & peripherals (other than PCs)	$6,596	14.5%
Personal computers	6,073	13.9
Video (other than TV)	3,578	7.8
Telecommunications	3,448	12.7
Other industrial equipment	2,111	9.3
Video games and education	1,820	14.0
Audio	1,755	3.1
Copiers and other office equipment	1,163	7.0
Total semiconductor demand: $33,350		

Note: Numbers listed do not add up to total because of omission of some minor categories

Y135=$1

Source: EIAJ, NRI

Growth in Japan will average 10.6% through 1995, while the rest of the world will manage only about 9%, according to a new study from the Electronic Industry Association of Japan, with input from 50 Japanese electronics companies and Nomura Research. Even the rest of Asia will average only 9.9%.

Topping Japan's shopping list will be more sophisticated chips to be packed into current products—and the Japanese will likely pack more in faster than anybody. The study figures semiconductors now account for about 10% of the value of industrial electronic equipment in both the U.S. and Japan. But Japanese use will increase faster, reaching 14% by 1995, while the U.S. reaches 13%.

NRI figures the value of MOS memory and logic chips in all kinds of electronic equipment will nearly double by 1995. MOS memory for telecom, for example, should climb from $350 million in 1990 to $650 million in 1995, while MOS logic jumps from $700 million to $1.4 billion. Faxes alone will use $890 million worth of semiconductors by 1995.

The market for video game and other entertainment machines will see only about 20% total growth, but chip content will almost double, from $930 million to $1.8 billion as use of MOS logic increases from $250 million to $540 million, and memory from $540 million to $1.1 billion.

—Paula Doe in Japan

SOFTWARE

U.S. software breaks down Japan's PC market barriers

The next generation of operating system software from IBM, Microsoft, and others should help U.S. companies penetrate a potential $10 billion PC-software market in Japan. Until now, this market has been safely isolated from foreign competition by the twin barriers of the unwieldy Japanese language and proprietary computer architectures, such as NEC's version of DOS. No longer.

A new generation of industry-standard operating systems and user interfaces, led by IBM's OS/2 for Japan, DOS.V, and Microsoft Corp.'s Windows, are designed to easily accommodate the Japanese language and Japanese computer architectures. That means market opportunities for U.S. PC vendors who can sell in Japan the same machines they sell at home and still run Japanese software.

Likewise, U.S. suppliers of application software can adapt their products for the Japanese market with far less effort. And it's not a market to be sneezed at. The Japan Personal Computer Software Association estimates that sales of PC package software in Japan reached about $2 billion last year. International Data Corp. Japan figures although the market for all package software in Japan is only one-third that of the U.S., it's growing about 19% a year and will reach $10.6 billion by 1995.

Indeed, U.S. software companies may be surprised to learn just how successful Japan's trade press expects them to be. The influential *Nikkei Electronics* made much of the big opportunity for U.S. software vendors in a recent cover story detailing the advances in "international" software from Apple, IBM, Microsoft, and Novell. Domestic Japanese software companies, the story concluded, are in for big trouble as U.S.-made software starts to flood the Japanese market.

"Windows and IBM's OS/2 for Japan make porting significantly easier," notes David Pollack of the American Electronic Association Japan's office, who has just finished putting together a book for software companies interested in penetrating the Japanese market. (The book will be available from the AEA in July.) "You still have to do some tweaking with things like screen size, but very little," he says. "Porting work may be cut from, say, a year down to a month."

Making applications handle the complex Japanese language is easier now that system software and user interfaces can handle the two-byte code needed to deal with Chinese and Japanese characters. Parts of software applications that need to be altered for different countries, such as menus and currencies, are also separated from the core software for easy conversion. Moreover, much of the initial conversion work can be done in English on standard DOS-based computers, thanks to products such as the new Far East developers kit due out from Microsoft.

How much headway are these operating systems making in Japan? With Japanese computer makers providing the OEM channel, some 200,000 copies of Windows had been sold in Japan as of March, and that's expected to reach perhaps 500,000 by the end of this year. Only 10% of all applications sold in Japan by major U.S. software makers were for Windows in 1991, according to the Software Publishers Association, but by year's end, the rate was running 25%. Windows applications are expected to account for 25% to 30% of all U.S. applications sold in Japan in 1992.

—Paula Doe in Japan

DATA STORAGE

DAT market growing—at Exabyte's expense

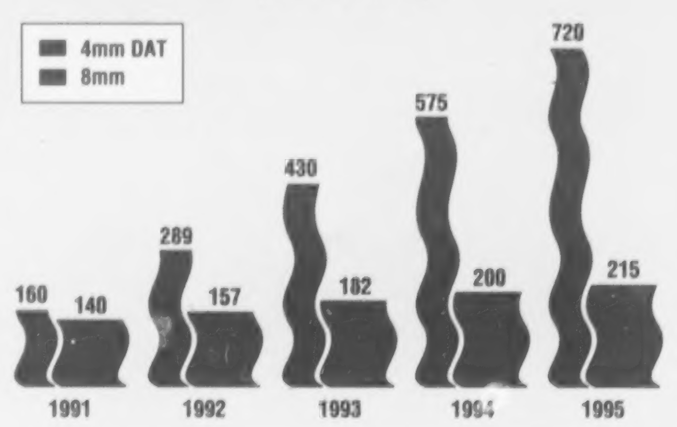
When 4-millimeter digital audio tape drives arrived three years ago, about 30 companies swarmed into the high-capacity low-end data backup storage market that was first blazed by Exabyte Corp., the lone U.S. supplier of larger 8mm tape drives. Now, after two years of bloodletting and consolidation, the $224 million 4mm market consists of just five significant producers, says Lee Elizer, president of consulting firm Data Storage Concepts.

Despite such consolidation, more 4mm drives were shipped last year than 8mm, according to Elizer—a significant fact, since Exabyte has grown astoundingly fast (to $250 million) on demand for its 2.5- and 5-Gbyte 8mm drives.

"Exabyte's 2.3-Gbyte drive had a lot more lightning than they thought," says Bob Abraham, Freeman Associates' vice president, explaining why Exabyte exceeded stock analysts' expectations for at least two quarters.

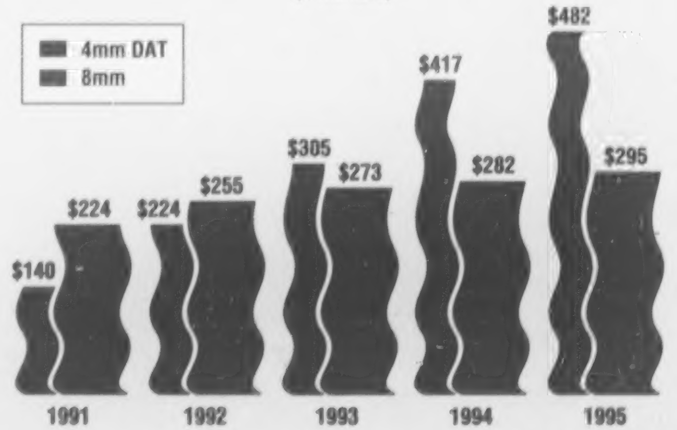
4mm outpaces 8mm in unit shipments...

(units in thousands)



...but 8mm generates more revenue

($ millions)



Source: Freeman Associates

The leading merchant DAT vendors in terms of unit shipments are Archive, Hewlett-Packard, and Rexon (which owns Wangtek and recently acquired competitor WangDAT). Market analysts say HP and Archive are a toss-up for the merchant market share lead at about 35% apiece; Wangtek/WangDAT is a distant third. Trailers include Sony, GigaTrend, R-Byte and Toshiba.

The OEM market competition between 8mm (Exabyte) and 4mm DAT is still hot, however. DAT vendors have relied for the past year upon data compression (both hardware and software) to raise capacities of the base 1.3-gigabyte drive design to 2.5 Gbytes, but Exabyte is starting to cull production of its cash-cow 2.5-Gbyte drives to push sales of higher-margin, higher-performance 5-Gbyte drives.

What DAT loses in performance, it makes up for in size: It is smaller with a 3.5-inch form factor than 8mm, which only comes as small as a half-height 5.25-inch disk drive.

—David Webb in San Jose

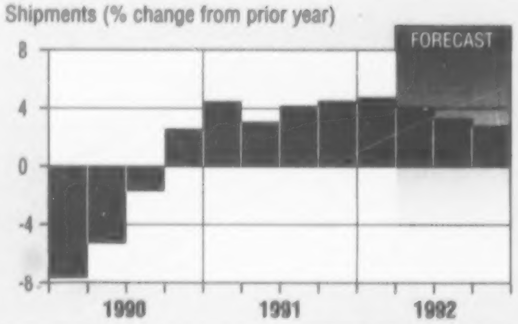
ELECTRONIC COMPONENTS

Component industry recovery begins, despite orders blip

Electronic components makers should expect industry shipments to advance 8.2% to $68.6 billion this year and 11.4% to $76.5 billion in 1993. This recovery is not great by historical standards, but any turnaround is a relief after a couple of sluggish years. Thanks to a pickup in demand from computer and communications equipment makers, component shipments—everything from chips to wire—climbed 4.3% above year-ago levels in the final quarter of 1991, and the trend continued through the first quarter of 1992 as shipments advanced 5.3% to $16.1 billion. Two consecutive quarters of solid growth have been a long time coming; the last time the industry reported similar growth was during late-1989.

The industry isn't free from worries yet, however. New orders for electronic components fell 8.2%, 3.8%, and 10.5% from year ago levels in February, March, and April 1992, respectively. But with end-markets for components—particularly computers, communication equipment, and instruments—reporting growing orders, the drop in component orders is expected to be temporary. Another indicator that bodes well for component makers is buyers' reports on delivery times. According to a monthly survey of 500 buyers by our sister publication *Electronics Purchasing* magazine, lead times have finally begun to stretch. Delivery times for electronic components have risen about 2% during the 12 months ending June 1992, up from the 5%-plus declines of a year earlier.

—Julie Handelman-Sagan



($ billions)					FORECAST			
Orders	6.87	6.62	7.24	6.88	**7.02**	**7.15**	**7.45**	**7.19**
Shipments	6.97	6.90	7.17	7.16	**7.18**	**7.19**	**7.49**	**7.50**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
	1991			**1992**				**1993**

Source: Commerce Dept.; Forecast: Cahners Economics

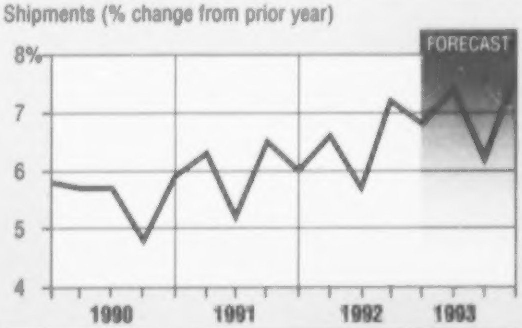
INSTRUMENTS & ATE

Higher productivity needs drive measure & control sales

The measuring and controlling (M&C) instruments market will grow a modest 4.1% to $29 billion this year followed by 3.7% growth to $30.1 billion in 1993. Historical data suggests that demand for M&C instruments should not have begun rising until after the nation's factories pick up steam and begin expanding in late-1992 and 1993. Although industrial output increased through the first five months of this year, factory capacity utilization rates remained low. Businesses, however, struggled to cut costs and improve productivity during last year's recession. As a result, demand for M&C equipment has been benefiting earlier than usual during the 1992 upturn. Orders, for example, surged a strong 13.6% in April from a year ago, offsetting two declines in February and March.

Of course the variety of M&C instruments responsible for a 4.5% year-over-year rise in shipments during the first quarter of 1992 are the lower-priced equipment used in control processes. The higher-cost, higher-tech test equipment continues to suffer from tight capital budget restraints in 1992. The ELECTRONIC BUSINESS automatic test equipment (ATE) sales index fell 5.9% below year-ago levels during the fourth quarter of 1991 and slipped 0.3% during the first quarter of 1992. ATE sales are expected to fall 2.5% in 1992, but higher production and quality demands in 1993 will loosen the reins on capital spending so that the ATE index will rebound 8.8%.

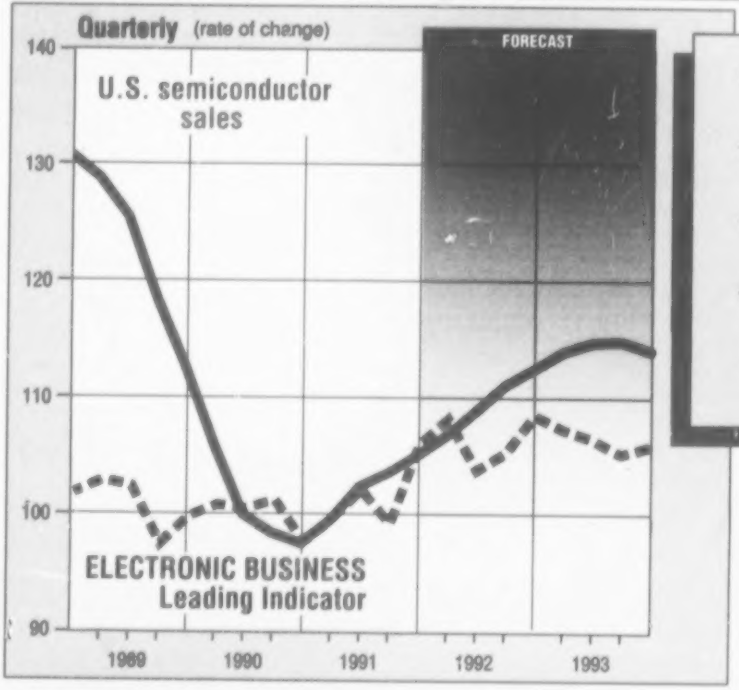
—John Farrell

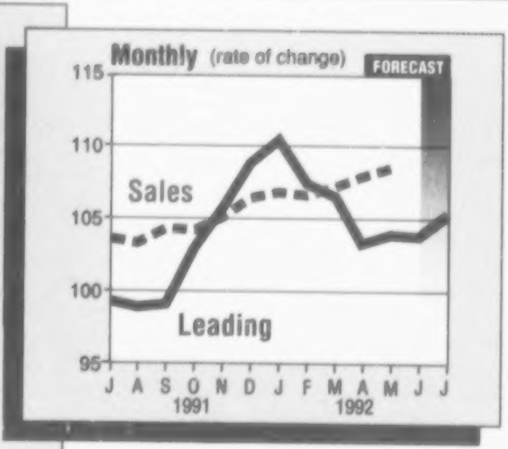


($ billions)					FORECAST			
Orders	15.6	15.7	16.9	15.8	**16.7**	**17.3**	**19.0**	**18.0**
Shipments	15.9	15.9	16.3	16.1	**17.1**	**17.4**	**18.1**	**18.0**
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
	1991			**1992**				**1993**

Source: Commerce Dept. & *Electronics Purchasing*; Forecast: Cahners Economics

ELECTRONIC BUSINESS Leading Indicator

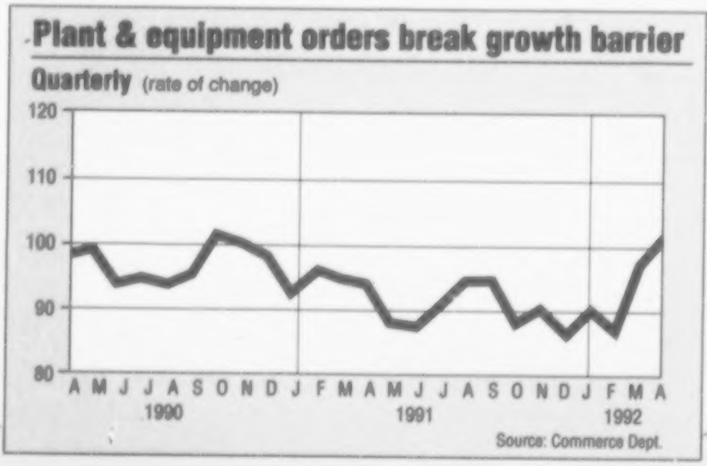




Indicator back on track this past May

The ELECTRONIC BUSINESS Leading Indicator (EBLI) rose from a revised 103.3 in April to 103.9 in May. That positive step, no matter how slight, is a welcome sign after last year's downturn (which began with a drop from 103 in April to 101 in May.) Signaling a recovery in progress, EBLI has now recorded eight consecutive months above 100. In fact, EBLI has remained above 103, the longest such streak since 1988. The current EBLI upturn began last October and has already been followed by a rebound in the chip market.

—*John Farrell*



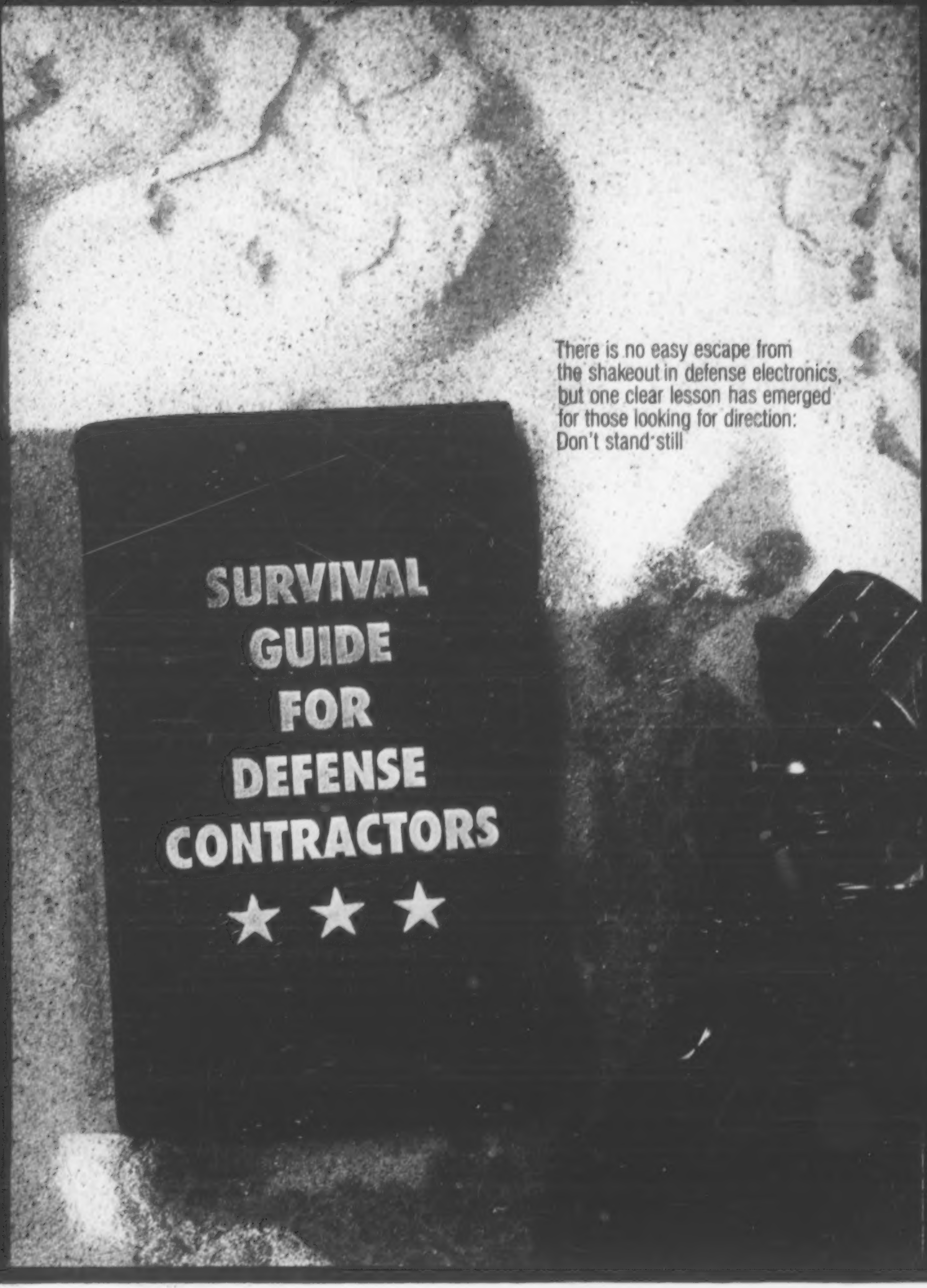
Plant & equipment orders break growth barrier

Source: Commerce Dept.

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, May)	103.9	103.3	101.1	101.6
U.S. semiconductor bookings ($ millions, 3-month average, May)	$1,608	$1,605	$1,368	$1,311
Weekly hours of semiconductor production workers (monthly average, Apr.)	42.8	42.8	40.8	41.1
Electronic components lead time index (1977 = 100, Jun.)	68.4	83.7	94.2	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, May)	81.4	82.1	73.2	68.5
Change in electronic components inventories ($ millions, SA, Apr.)	-$44	-$34	$91	-$53
Contracts and orders for plant and equipment ($ billions, SA, Apr.)	$36.7	$37.7	$34.1	$35.0

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics


SURVIVAL
GUIDE
FOR
DEFENSE
CONTRACTORS
★ ★ ★

There is no easy escape from the shakeout in defense electronics, but one clear lesson has emerged for those looking for direction: Don't stand still

SURVIVAL GUIDE: CHAPTER ONE

By Peter Burrows

It is literally do-or-die time for thousands of the subcontractors and captive electronics suppliers that serve the U.S. Department of Defense. Blindsided from their cozy existence under the Pentagon's wing by the crumbling of the Soviet Bloc, many have already gone bankrupt, been acquired, or simply closed their doors. Others, with multiyear contracts coming to an end and few new projects in the hopper, are frantically searching for new strategies to help them survive—at least until the new shape of the U.S. military-industrial complex emerges.

It is difficult to quantify the damage, as the government leaves the tracking of these lower tiers of the defense market to its prime contractors. The U.S. Congress's Office of Technology Assessment does estimate that small companies received about $47 billion in DOD contracts and subcontracts annually from 1986 to 1990, but there are indications that this level of funding is falling even faster than the defense budget (see box).

The bottom line? As bad as it is for the prime contractors, life is even tougher for some of the little guys.

Consider, for example, the plight of Lau Technologies, a $25 million military contract manufacturer in Acton, Mass. It gets about 50% of its sales assembling boards for the Bradley M1 fighting vehicle, which will be discontinued in 1994, and the Abrams M1A2 tank, of which the government has decided to buy just 63, down from the 8,000 order around which Lau structured its bid.

Although Lau's productivity is above average and its customers seem satisfied—it received an U.S. Army Contractor Excellence Award in September 1991 for service rendered during the Gulf War—the company expects to lay off half its 190 workers if no unexpected procurements come through by year's end. As for the future, its executives have few answers. "We just have to hope the DOD continues to need the kind of capabilities we supply," says James Bender, vice president of the company's land systems division. "If they do, we'll survive. If they don't, we won't."

Clearly, however, this is no time for stoicism. Although most captive defense suppliers lack the marketing expertise and cost efficiency to compete outside their home market, they are nonetheless heading off in a variety of directions. Favorite destinations include the defense agencies of foreign governments, non-DOD U.S. government agencies such as NASA and the Department of Energy, and commercial markets.

Such transitions would be hard enough in the best of times. Unfortunately, an almost eerie set of roadblocks—including the worldwide recession—has emerged that threaten to snarl such survival plans at almost every turn:

- Don't count on foreign defense sales. While nations such as Saudi Arabia, Korea, and Japan are buying military goods to compensate for reduced superpower spending, federal COCOM export control regulations prohibit or complicate sale of many systems and components, giving the advantage to aggressive European exporters;
- Don't expect an easier time selling to DOD or other federal agencies after the shake-out. The U.S. military may still be the world's biggest electronics customer, but the dearth of new platform starts has led many prime contractors to compete for the lower-volume contracts that have been the life-blood for lower-tier suppliers. "We now see 80 bidders where we once saw three or four, and the newcomers include companies like Boeing and Rockwell," says Jim Smith, president of AIL Systems Inc., a subsidiary of Eaton Corp. in Deer Park, N.Y. The result, predictably, is a tougher fight for every contract. AEL Industries Inc., an

avionics and electronics subsystems maker in Lansdale, Pa., reports that its win ratio is down from about 70% five years ago to about 35% today, and president Mark Ronald expects it to go down even more. The consolidation of military programs, such as the Air Force's merging of its Strategic Air Command with its Tactical Air Command, heightens the problem by reducing the number of overall DOD customers;

- Don't assume continued business from your existing customers in the contractor community. In an effort to avoid further layoffs and utilize empty capacity, many prime contractors are sub-contracting less and working to become more vertically integrated. Raytheon Corp. in Lexington, Mass., for example, has reportedly pulled much manufacturing in-house to meet union commitments regarding downsizing;
- Don't bank on moving into commercial markets. While this is the strategy currently in favor with the policy gurus, executives say this is the most unlikely survival path of all. Having served just one end-customer—the DOD—for all their lives, captive suppliers typically lack the marketing and distribution expertise to break into already cutthroat commercial markets.

Dave Bradley

"Conversion is a myth," says Lau Technologies' president Joanna Lau. "What commercial markets can we walk into with this recession going on?"

"A book about successful diversification in the defense industry would be the shortest book ever written," notes Jack Modzelewski, vice president of aerospace and defense for PaineWebber in Manhattan. The lesson, he says, is clear: "Diversify at your own risk!"

Sizing up the coming shakeout

	Decrease in contract obligations, 1985-1990	Decrease in prime contracts awarded, 1985-1990
Aircraft industry	52%	17%
Communications equipment	33	16
Electronic components	40	16
Guided missiles	35	35
Tanks	56	37

The number of DOD contracts awarded is down, but not nearly as much as overall defense spending. That means overcapacity and probably reduced subcontracting, neither of which is good for the defense electronics supplier base. "One thing is clear," says Defense Budget Project analyst Conrad Schmidt. "Someone other than the primes have been absorbing the blow."

Source: Defense Budget Project

So what is the small defense electronics company to do? First of all, avoid shellshock and take a frank reckoning of your strengths and capabilities. Here are some of the key factors to consider when charting your course:

- Who are your key customers? With the prime contractors in as much disarray as their suppliers, their new strategies may be the most critical factor in your long-term plans;
- How big is your company? Small companies in large markets that have superior technology and broad service can probably survive as non-diversified DOD suppliers—assuming no prime contractors have decided to steal their markets at any cost. "We're waiting to see how rapidly the defense environment collapses," says AEL president Ronald. "We just want it to get to steady state, because at our size we know we can find a place for ourselves. After all, the U.S. defense market is still the biggest in the world;"
- Check your backlog. Companies that have years left on key programs may take more time and invest more prudently to develop long-term diversification plans. If the well is dry or almost dry, it may be time to downsize, take on debt or issue stock to raise restructuring capital, or find a partner. "The DOD may find dollars for your project, but you can't afford to wait to find out,' says Steve McCann, manager of business development for Codar Technology Inc., a ruggedized workstation vendor in Longmont, Colo. "You have to cut to the chase."

The result of all this strategizing is mass confusion. Some companies are racing to commercial markets; others steer clear. "When we see a commercial market, we run," says Ron Hehr, manager of tactical marketing for United Technologies Microelectronics Center, a UT sub-

Tracking one cutback down the defense supply chain

WHEN RUMBLINGS BEGAN in 1989 about possible reductions in the procurement of the Abrams M1A2 tank, prime contractor General Dynamics Corp. surveyed 140 of its project subcontractors to learn how they would respond should the bad news come to pass. Of those polled, 15% said they would go out of business and another 15% said they would be forced to close a facility.

Unfortunately, the worst fears seem likely to come true. Not only has the Pentagon reduced its procurement plan from 8,000 to just 63, but GD's campaign to have DOD upgrade about 3,300 of the earlier generation M1A1s has bogged down. Concerned by the withering industrial base for the program caused by these cutbacks, the Saudi Arabian government is reportedly reconsidering a $10 billion 465-tank order.

Unfortunately, the bloodshed among GD's 9,000 suppliers seems to be right on schedule. Tom Bledsoe, VP of materiel for GD's land systems division, points to a smattering of Chapter 11 filings. Far more common, as the chart shows, is painful downsizing throughout the supply chain. ☐

M1-A2 tank cutback does industry damage

Here is some expected fall-out if the government reduces procurement from 8,000 to 63 as planned

The prime contractor. The land systems division of $8 billion General Dynamics will not dole out the $3 to $5 billion in contracts it had planned to award over the next 8-10 years.

The sub-contractor. $150 million-plus Smith Industries, which builds the MI-A2's position navigation system, will lay off 10% of its work force and eat 50% of its R&D costs on the tank program.

The services company. $25 million contract manufacturer Lau Technologies will not build the mil-spec circuit boards that bring in almost half of its sales, and will layoff half of its 200 employees.

The components supplier. $10 million hybrid IC maker White Technology will lose half of its sales as well, and will layoff 25% of its 120 employees.

sidiary in Colorado Springs that makes radiation-hardened ICs.

One company running in the opposite direction is White Technologies, a specialty memory and hybrid IC maker in Phoenix. Soon after the decision to reduce procurement of the M1A2 tank was announced, White's management sought out commercial markets for the chips developed for the tank program. "Five of our customers were involved with that tank, so it really affects us," says Dan Tarantine, senior vice president of sales and marketing for the $10 million company.

Going commercial won't be easy. Tarantine even has doubts White will fully recoup the $1 million it invested in the tank program, as high overhead costs related to its continuing military business make it very difficult to compete in the more price-sensitive commercial market. For example, the company must maintain a three person staff to ensure compliance with DOD specifications and must comply with a time-consuming equipment calibration regimen. Ironically, these costs have forced White to bypass its own fab and outsource manufacture of the commercial chips to a contract house in the Philippines.

If there's a lesson in White's predicament, it is that knee-jerk reactions rarely work; well-developed diversification strategies are required. One company that has done this is ThermoTrex Corp., a subsidiary of Thermo Electron Corp. in Waltham, Mass. "Our objective has always been to use the funding that defense contracts afford you to come up with commercial applications," says president Firooz Rufeh.

In the past, the company has used this philosophy to convert a technology to measure minute quantities of gases into a product to measure carcinogen levels in foods and has converted an explosives-detection system into a drug-detection system. When DOD cutbacks drained this reliable capital pool, the company went public last year to fund development of three more follow-ons to military products, including a radiation-free medical imaging product and a microwave camera to help commercial pilots see through fog.

ThermoTrex plans to increase its proportion of commercial sales from about 20% today to about 50% in the next few years and ultimately to about 80%. The company has much in common with the coterie of DOD suppliers who have successfully made the jump to the commercial world. For one, it has set up separate operations for its commercial efforts. It has also set realistic time horizons; like many executives, Rufeh gives commercial ventures 12 to 18 months to show signs of life.

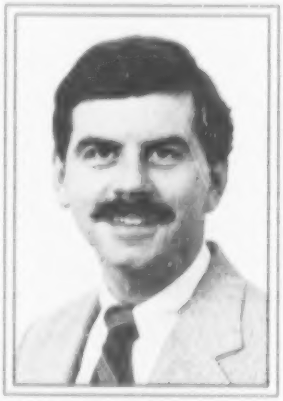
"Unless the defense supplier has successfully set up an entirely separate commercial entity and brought in commercial managers, then I don't see much chance for success," says Dataquest analyst Greg Sheppard.

"You have to break people out of their old organizations," agrees AIL's Smith. "Otherwise they're too comfortable." Having clearly stated his intention to develop at least one successful non-DOD business, Smith set off 10 company veterans, gave them direct access to his office, and a promise of necessary funds.

Given defense electronics companies' traditional lack of marketing experience, many have hooked up with strategic partners to get their commercial campaigns going. In addition to its defense business, Aeronvironment Inc., a well-diversified R&D house in Monrovia, Calif., has long worked with GM to develop solar- and electric-powered vehicles for the commercial market. Group Technologies Corp., a contract manufacturer that was spun off when Honeywell Corp. began divesting many of its defense businesses in the mid-1980s, has used its expertise to jointly develop products with AT&T and Lockheed Corp. The AT&T product, which promises to bring conference calling to secure communications, will be announced later this year.

Of course, a company's current product line will determine the success of any conversion strategy. Those who can easily spin off core DOD-related competencies to other markets are best off. Group Technologies, for example, used the secure communications technologies it inherited from Honeywell as a building block for a $30 million market in electronic key management systems—a market that developed after the Walker spy ring exposed the security risks associated with paper-based security codes. Lau, while actively avoiding commodity markets, plans to bring its manufacturing expertise to the medical electronics market. "In both medical and military markets, we're talking about life and death," says president Joanna Lau. "Customers in both need the quality and reliability we offer."

SOME TRULY RADICAL diversifications are in the works. Aeronvironment has pursued an eclectic array of markets for its 6-foot-long, 8-pound unmanned flying vehicles. Used during the Gulf War for surveillance and reconnaissance, they are under evaluation by the Los Angeles Police Department and have been looked at by whale watchers, forest-fire spotters, and even papparazzi in search of a birds-eye view of Elizabeth Taylor's wedding. AM General, a division of LTV Missiles and Electronics Group, is selling civilian versions of its jeep-like Humvee (high-mobility multipurpose wheeled vehicle) for around $40,000. Its new customer base includes Arnold Schwarzenegger.



"It's hard to make our supplier base secure," says General Dynamics VP Tom Bledsoe. "We can only keep them informed"

The most fortunate DOD suppliers of all are those that find their best opportunities in their existing markets. AEL, for example, has maintained its revenues through the downturn on the shoulders of some prudent decision-making in the late 1980s, when the company invested heavily to get entrenched in electronics-laden tactical programs that have for the most part escaped the cutbacks. "We have been reasonably successful in guessing," says Ronald, the company's president. "We didn't go in for SDI, the B-2 bomber, or any antiballistic missile programs—although some of that was just plain luck."

More recently, AEL has focused on its aircraft retrofit business. For one, this business is at the heart of DOD's strategy to remain preeminent through upgrades rather than with new weapon platforms. Also, an airport facility is required to get into the business—an imposing entry barrier to would-be competitors, notes Ronald. He adds that budgetary pressures on DOD program managers has forced them to look beyond the primes who monopolized the upgrade business just 10 years ago. "We're even getting sole source business now; for the first time, the Pentagon has taken to calling us direct."

Others are in less enviable positions. Many makers of ruggedized computers, such as C3 Inc. and KMS Advanced Products, have flirted with Chapter 11 or been acquired as a result of rising competition from a host of prime contractors in search of high-volume computer contracts. C3, a $106 million company based in Herndon, Va., recently lost a Navy contract that had supplied 70% of its revenues to $11 billion Hughes, despite being the incumbent. "Hughes would have never looked at that contract before, but they cleaned our clock," says Bob Moreno, executive vice president of sales and marketing. "We couldn't have taken the contract at the price they got."

That experience reinforces the perception that even companies not prepared or not interested in going commercial must make big changes to survive as captive DOD suppliers. For one, such companies must buddy up ever closer with their customers, no matter how difficult those customers make the experience.

"When the Berlin Wall came down, many of the primes we do business with stopped making multiyear procurements and went to single-year buys," says White Technology's Tarantine. "When the Soviet Union fell, many went to a quarterly schedule."

Despite similarly shortened schedules, Joanna Lau continues to make bulk purchases of supplies in an effort to keep costs down at the contract manufacturing house she runs. "It's a big risk, since I won't be reimbursed" if follow-on orders don't come in, "but you have to act without a safety net now," she says. "You either come out OK or you're a loser. But, hey, this is scramble time."

An almost eerie set of roadblocks, including the recession, threaten to snarl survival plans at almost every turn

Lau also continues to bid contracts at less than the expected cost—standard operating procedure in the heady days of the Cold War. This risk-it-all approach may work for some, but most observers insist that conservatism is required now. "Anyone with any sense will charge everything at cost," says UTMC's Hehr, even if it does give heartburn to program managers used to low-ball bids.

Increased openness regarding R&D plans and financial health can help counteract such disappointment. But don't expect a revolution in customer relations. With their own pains at an all-time high, prime contractors and program managers are not likely to go far out of their way to assist their suppliers.

General Dynamics, for example, figures it must downsize from 105,000 employees in 1987 to just 63,000 by 1995, and plans to reduce capital spending from $1 billion in 1990 to $575 billion in 1993. "It's hard make our suppliers secure, since we can't tell them anything more than we know," says Tom Bledsoe, vice president of materiel for GD's land systems division in Sterling Heights, Mich. "All we can do is keep them informed." To its credit, GD has involved key suppliers in an all-out public relations blitz on Washington to save the M1A2 program, and has put together an impressive communications program to keep suppliers as up to date as possible.

The government has been no more helpful than the primes, say suppliers. Despite good intentions at the policy level, program managers continue to succumb to low-ball bidders and to drive down profits by seeking dual sources even for small contracts. Despite talk of waiving certain DOD regulations on commercial companies subcontracted by defense suppliers—so long as the supplier accepts responsibility for the quality and reliability of resulting products and services—few program managers have given up this level of control. The added regulation sends most would-be commercial vendors running, driving up program costs.

Despite the seeming confusion, there are some common threads through the maze of emerging strategies. First and foremost is the need for world-class quality and productivity. This trend began even before the worst cutbacks occurred; General Dynamics, for example, has slashed its supplier list from 1,200 in 1988 to about 600 today through a total quality management drive.

Paramax Systems Corp., the recently renamed defense division of Unisys Corp., provides a good example of what needs to be done. By increasing its training budget by about 300% and increasing spending on automation by 10% annually—despite four years of flat revenues—it is improving productivity by 10% a year, says vice president W. Lee Shevel. The results include a $400 million-plus contract to develop ground-based software for NASA's space shuttle program and a $39 million order for air traffic control systems for the Federal Aviation Authority.

Unfortunately, most of this year's productivity gains will be the result of downsizing—possibly to the tune of 1.5 million jobs lost nationwide by the time it's all over, according to the OTA. As always, the secret is to cut as aggressively as possible without threatening the survivability or core competencies of the company. AIL's Smith, for example, oversaw the reduction of the company from a 5,300-person, $960 million entity in 1988 to a 1,700-person, $250 million company today. Although painful, the company has not lost money through the transition.

One area that should not be trimmed, however, is marketing. "Many of the guys running small defense companies set up shop 20 or 30 years ago with a good idea and one or two customers," says analyst Barry Blechman, president of Defense Forecasts Inc. in Washington, D.C. "Now they are having to learn how to market their products." ☐

SURVIVAL GUIDE: CHAPTER FOUR

Why the DOD budget isn't all gloom and doom

Yes, it's falling like a rock, but smart companies still have a few new opportunities to get a piece of a $38 billion pie

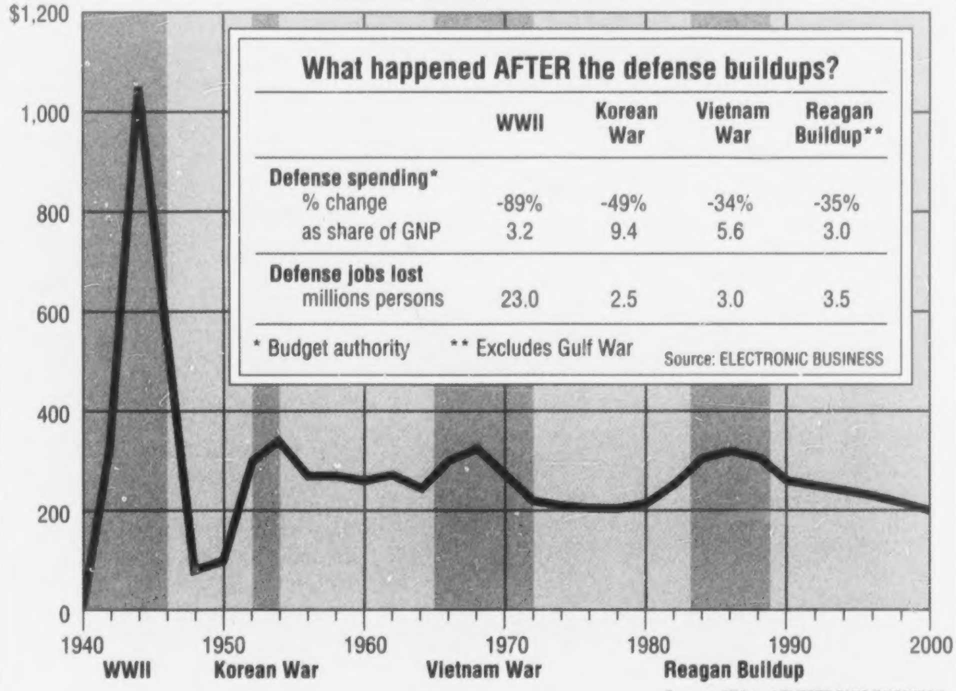
E. B. Baatz

Digging into the Defense Department budget isn't a task for the faint-hearted: The funds are plummeting, and the budget process is in chaos. Behind the negative facade, however, some signs of opportunity flash, especially for electronics manufacturers.

Interpretations of the budget vary. Take the contrasting statements made at last April's Electronic Industries Association (EIA) budget conference. McDonnell Douglas's Robert Brownlee, chairman of the EIA's de-

The defense budget over history

Military spending ($ billions, 1992)



What happened AFTER the defense buildups?

	WWII	Korean War	Vietnam War	Reagan Buildup**
Defense spending*				
% change	-89%	-49%	-34%	-35%
as share of GNP	3.2	9.4	5.6	3.0
Defense jobs lost				
millions persons	23.0	2.5	3.0	3.5

* Budget authority ** Excludes Gulf War

Source: ELECTRONIC BUSINESS

Source: OTA and ELECTRONIC BUSINESS

fense forecast subcommittee, predicted that "the defense budget will remain a large and attractive market—$200 billion in real 1992 dollars by the end of the decade. There will be a healthy industrial environment for those that survive." Later that day, however, consultant Charles M. Herzfeld, former director of the Department of Defense Research and Engineering, warned that "budgets will go down faster than we are planning for. That implies a large force reduction and a large procurement reduction."

The problem for the defense-electronics industry, of course, is that they're both right.

If there is a strategy in the defense cuts—and experts disagree on that, too—it's that the emphasis of future weapons acquisitions will be on equipping a smaller, quicker, more mobile force to fight regional conflicts now that the Soviet nuclear threat has vanished. That means more opportunities for electronics makers. So while the total defense procurement and RDT&E (research, development, test, and evaluation) spending will fall about 3% annually from now to 2000, Barry Blechman, president of International Defense Technology Inc. in Washington, D.C., predicts defense electronics will grow 2% annually. Appropriations for defense electronics will bottom out in fiscal 1993 at $38 billion in constant 1992 dollars, down from a peak of more than $60 billion in 1985, and will gradually increase to $47 billion in real dollars by the end of the decade.

Although Blechman is somewhat more bullish about prospects for defense electronics than the EIA or others, most analysts agree that space systems, surveillance, communications, simulation, and related electronic-based functions will receive priority funding in the emerging military. The winners will include

Defense cuts hurt some regions more

CONGRESS'S BIGGEST concern about the defense cuts being considered now isn't the strength of the U.S. military. It's jobs. In 1987, at the height of the Reagan-era defense buildup, 6.7 million people were employed in defense industries or in the military. Estimates of total defense-related job losses in the next five years range from 906,000 jobs (assuming the Bush's fiscal 1993 budget holds) to more than 1.5 million under the worst-case scenario, in which defense spending drops to $169 billion by the year 2001. Some of these jobs will be lost due to attrition. In nine years, defense-related employment could go as low as 3.6 million, a 46% drop from the 1987 peak, says the Congressional Office of Technology Assessment (OTA).

Most experts expect the impact of these job losses on an economy that employed 119 million people in 1991 to be relatively minor, especially compared with the cuts after the Vietnam War. Yet several factors—such as the lack of a government plan to take defense contractors back into the civilian market, relatively weak economic growth expected over the next decade, and burdensome debts—may make the transition for ex-defense workers tough.

Over half of all defense spending in the U.S. took place in eight states (see table.) The pain of the defense cuts will indeed be severe for some communities. "When GE Aerospace employment drops from 7,800 to 2,900 in a town like Pittsfield, Mass., with its population of 50,000, the community effects are just as devastating as if a whole defense company had gone out of business," say OTA policy strategists.

Finally, because defense industries employ a greater-than-average number of engineers, these professionals will face a special challenge. About 342,000 defense engineers were employed in 1990; up to 127,000 of those jobs may be gone by 1995. ☐

Ten states hardest hit by defense cuts

Defense industry employment, fiscal years

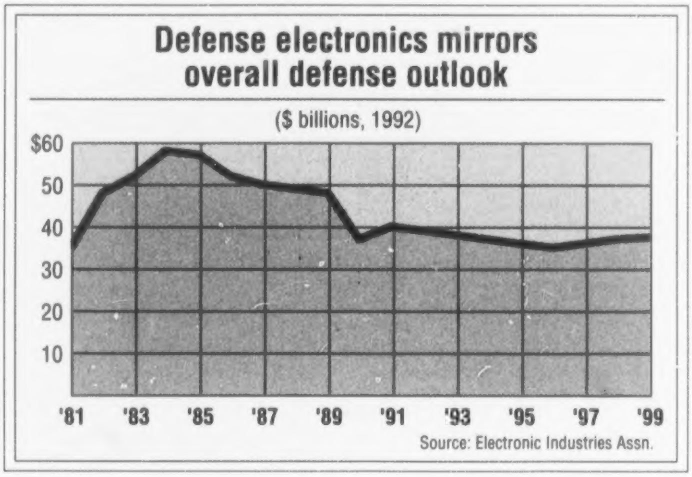
	Defense in 1991		1991-1997
	Number employed	Share of all employment	Number of jobs lost*
California	569,523	4.1%	149,931
Texas	202,676	2.5	62,264
New York	185,532	2.4	59,291
Virginia	155,270	4.9	48,340
Massachusetts	140,352	4.8	41,646
Ohio	132,442	2.6	41,537
Pennslyvania	123,108	2.2	38,140
Florida	119,406	2.0	35,693
Connecticut	99,419	6.0	35,065
New Jersey	93,841	2.5	28,719

*Employment effects under Bush fiscal year 1993 DOD budget

Source: Defense Budget Project

new command, control, and communications systems; upgrades of avionics and electronic warfare systems; development of new tactical missile systems and "brilliant" munitions; a proliferation of space-based assets and their integration with tactical forces; advanced computers and data communications systems; and advanced inter-netted simulation systems that will allow several battalions to simulate entire battles together.

The question for corporate planners boils down to pinpointing exactly which programs will thrive and which ones will die. Finding those answers isn't easy; decisions about individual programs tend to follow parochial lines, and there's little political consensus about specific programs. "[The debate] is no longer between hawks and doves," says Byron Callan, defense analyst for Prudential Securities in New York. "It's between those [Congressmen] who want jobs and those who don't have jobs in their districts."



Source: Electronic Industries Assn.

All this leads some to doubt the efficacy of forecasting which weapons programs will win and which will lose. "I don't think [the government] has a strategy. They are playing a big politicized game," says Robert Costello, former undersecretary of Defense. If there's any rationale to the cuts, he conjectures, it's that "projects with a proven, successful track record will be continued. If a program is questionable, then it is sure death now. Congress has a lot of money to spend, and they'll spend it where they won't get criticized."

WHILE WEAPONS procurement and operations and maintenance accounts in the defense budget draw much criticism in Congress, R&D appears to be a safer bet.

"The only consensus among the mainstream is to protect R&D accounts," says defense analyst Tom Baranauskas of Forecast International/DMS in Newtown, Conn. In fact, the weapons procurement account took a 7% hit from fiscal 1992 to the proposed 1993 budget. Government authorizations for all RDT&E rose 5.1% to $38.8 billion, which is 1.5% real growth, after inflation. That paints a rosy scenario for R&D, right?

Not necessarily. For example, the following paragraph from an analysis of the 1993 budget from the Defense Budget Project in Washington, D.C., implies the government's commitment to R&D isn't as strong as a cursory glance at the budget might suggest. "While the proposed fiscal 1993 budget includes a 1.5% increase in R&D funding from the *proposed* 1992 DOD budget, the proposed 1993 R&D budget represents a 1% real decline compared with the *enacted* 1992 budget, and a 5% real decline compared with the 1993 budget estimate included in the February 1991 DOD spending plan." In other words, the administration's commitment to defense R&D is far from optimistic.

Besides all this, R&D simply isn't as lucrative a business for defense contractors as the cost-plus, profit-loaded weapons contracts. "The R&D dollars you see in the budget don't translate into hardware. It's a lot of paper pushing," says analyst Greg Sheppard of Dataquest in San Jose.

The other major change in the defense budget is not of how much money or what types of programs to fund but how to spend the money. The fiscal 1993 DOD budget unveiled an entirely new acquisition strategy. Instead of starting production of new weapons systems before the R&D phase is completed, production now will wait until after R&D has been finalized.

The new strategy aims to minimize risks, says analyst Steve Kosiak of the Defense Budget Project. This approach will be complemented by increased funding to modify and upgrade current weapons systems so that they will last longer. To the extent that weapons upgrading means more sophisticated electronics, this trend represents an opportunity for some defense electronics manufacturers.

"Cutting back on 21st-century weapons and the new emphasis on upgrades and add-ons means a growing slice of the defense pie will

How one Wall Street expert sees the shakeout

JACK MODZELEWSKI, vice president for aerospace and defense at PaineWebber in New York, doesn't pull any punches. He is convinced that the U.S. defense industry is on a permanent downward slope and that defense industry workers will be hit hard during coming years. "How many defense analysts on Wall Street do we need to say the industry is going down?" he quips.

The defense market, Modzelewski notes, has clearly underperformed the S&P 500. When considering who to pick as winners or losers, he doesn't study the defense budget line by line. "From an investment perspective, that method leads to bad stock calls," he says. "Besides, it drives you crazy. The decisions about which programs get cut are driven by politics and costs and the budget is designed so you can't understand it."

Modzelewski forecasts defense spending will fall around 3% per year over the next five years and employment at defense companies will be cut 6% per year. "There will be tremendous pressure to keep margins up, so defense companies will be aggressive in reducing employment," he says. As companies continue to generate cash in their balance sheets by liquidating inventory, selling buildings, and the like, he expects defense company profits to increase over the next two years, but "this will be the last burst of brightness—like a supernova—before much worse profit performance in 1994 and 1995." If he is right, companies then will compete not just for lost dollars, but for their very existence. ☐

DOD budget cuts will produce tremendous pressure to keep margins up, so defense companies will aggressively cut employment, predicts PaineWebber's Jack Modzelewski

be going to electronics," agrees Dataquest's Sheppard. "Still, electronics won't be what it used to be." After all, even Blechman's 2% real growth for defense electronics projected to the end of the decade is a far cry from the 13% annual growth of the early to mid-1980s.

The ultimate extension of the DOD's new acquisition policy is a world in which volume weapons production may never occur. Instead, a single prototype would be built for testing. Critics of weapon prototyping, however, are concerned about how the nation can maintain an adequate military/industrial base. "It's baloney because we can't sustain the infrastructure, especially the tens of thousands of second- and third-tier contractors," warns Blechman. "Prototyping is simply being used as a rationale for program cuts."

Regardless of the underlying industrial policy debate, if the DOD's new acquisition strategy sticks, it will mean big changes for defense electronics contractors.

How far and how fast to cut the budget may still be in question, but most agree the decline may be sharper than expected a year ago. While the EIA expects the defense budget to remain at $200 billion in 10 years, others predict that another $40 billion will be cut.

The Bush administration's budget plan submitted in 1991 garnered savings in the defense budget in two ways—cuts in active duty military personnel and the termination of current-generation weapon systems.

Programs cut or postponed include the B-2 Stealth bomber, Advanced Cruise Missiles, the Midgetman missile, the Army's Air-Defense Anti-tank System, Comanche helicopter, Line-of-Sight Antitank system, and the Block III tank (the next-generation M-1 tank). DOD also proposes cutting future procurement of Seawolf submarines and rescinding funding already appropriated for a second and third boat. Canceled or scaled back also were the Advanced Air-To-Air Missiles and the Fixed Distribution System underwater surveillance system.

No matter how you look at those cuts, defense electronics contractors have been hurt. It's time, say many defense experts, for contractors to start looking for government customers outside the DOD. Unfortunately for company planners, that means digging into several hundred more pages of the Budget of the U.S. Government. ☐

Customers reap rewards of competitive capacitor market

Manufacturers see little market growth, but they strive to maintain—and gain—customers through service

By Barbara Jorgensen

If you're a large user of capacitors, 1992 could be your year. The prospect of continuing flat sales, defense-spending cutbacks, global recession, and vendor reduction has capacitor makers scrambling to differentiate themselves from a small but highly competitive pack. That, says one producer, means "servicing the heck out of the customer." It also means offering the right product mix as demand rises for surface-mount components and higher capacitance in an increasingly smaller footprint.

Vendors agree that customers are calling the shots—and they're all ears. Despite springtime optimism, capacitor sales are expected to be nearly flat this year. In the U.S., 5% growth is predicted at best, bringing the total market up slightly to $2.15 billion, according to New York-based Frost & Sullivan (F&S). Major capacitor end-markets—including automotive, consumer electronics, and computers—are still feeling the effects of the recession, although many capacitor vendors expect them to pick up by the second half of the year. First-quarter sales were good, although one vendor quickly adds that " 'good' is a relative term."

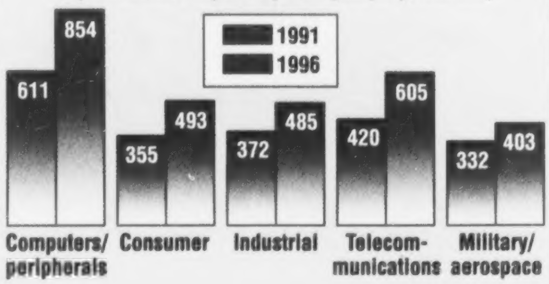
Of the major capacitor types—ceramic, tantalum, aluminum, paper, film, and variable—F&S expects that the latter three will continue to lose market share through 1996. Aluminum is predicted to experience a "modest" five-year growth rate.

Vendors report some bright spots in their telecommunications and surface-mount product lines. "Cellular is driving a lot of our business in the U.S.," says Tom Kuhl, marketing communications manager for Murata Erie North America in Smyrna, Ga.

Surface-mount (SM) capacitors—particularly those devices referred to as multilayer ceramic (MLC) and tantalum chips—continue to be in demand. MLC chips for SM applications account for 80% of all ceramic capacitors and 55% of the total market, says F&S. SM chips accounted for 50% of the solid tantalum market and 26% of the capacitor market.

Computer market to drive capacitors in '90s

Capacitor consumption by user groups ($ millions)



Source: Frost & Sullivan

"Everything that's surface-mount is immediately eaten up," notes Allan Cole, vice president for sales at AVX Corp. in Myrtle Beach, S.C. "We're right on the edge of not having enough." One large user of capacitors reports his operations are at about 80% surface-mount. The next drive will be toward smaller SM components, from the 1206 (0.12 in. by 0.06 in., used mostly in the U.S.) down to the 0402 (0.04 in. by 0.02 in., used mostly in Japan). "We have three to four suppliers who adequately serve the market now, but they'll need to press more toward smaller sizes," says the user. The Japanese currently are on the leading edge of smaller surface-mount components: The early push toward miniaturization in Japan's consumer marketplace prompted suppliers such as Murata Erie to emphasize SM chip development 10 to 12 years ago, says Kuhl.

Other suppliers continue to work on improved surface-mount versions, better electrical performance, higher frequencies, low profiles, and higher temperature tolerance. Fused tantalum, for instance, can protect circuit boards from overstressed tantalums that could cause a fire if inserted backwards. There is now no heavy demand for these in the United States, however; they're expensive to make and prices are still too high.

Overcapacity in leaded components– which make up half of some vendors' offerings—continues to depress prices for those products. And the overall sluggish market conditions have capacitor manufacturers working hard to keep, and maybe gain, customers who increasingly award their business based on intangibles such as quality and service. "We've worked hard to reduce our cycle times," says Greenville, S.C.-based Kemet Electronics' Ed Bost, "and we've gained business because our competitors couldn't deliver [on time], or customers' quality levels weren't being met."

Customers such as Hewlett-Packard Co., IBM, Motorola Inc., and General Motors Corp. long have had tough supplier-qualification programs in place, but vendors report that their second- and third-tier accounts now demand even higher quality and service. "We have to prove we can provide better service than a competitor," says AVX's Cole. That means problem-solving, technical assistance, working with customers on future product designs—as well as competitive pricing. AVX, for example, participated in a design-in with several space station subcontractors whose specs called for absolute reliability and extreme performance, size, and weight restrictions. AVX met the specs, and beat out the competition, by working with the customers on new materials, size, and packaging configurations. "When you are dealing with the design community, a project like this can establish that you'll be the first choice next time they need a specialty product. In a commodity market, those are the kinds of things you have to sell: and comprehensive set of designs, support, and ease of doing business," says Jeff Bartlett, AVX's director of product marketing.

Customers also demand services such as just-in-time (JIT) and dock-to-stock delivery programs, electronic data interchange (EDI), bar-coding capability, and supplier-managed inventory. "Our customers want everything," says Murata Erie's Kuhl. "We're hearing about EDI, which is really turning out to be schedule sharing. Customers send you a six-month window and expect the vendor to manage inventory. If you accomplish that, you're also doing JIT and dock-to-stock—it's putting inventory management back on the supplier. It's a tremendous amount of work, but also a tremendous opportunity—especially when you're talking about customers like Xerox and IBM."

Or like Motorola, which initiated an EDI-type schedule-sharing program with Murata Erie that was based on Motorola's proprietary software. Murata Erie had to learn to implement and use Motorola's system, as well as develop and download its own translation software so the systems could communicate. "There's no standard format we can use with *all* of our customers," says

Top capacitor suppliers

Estimated 1991 U.S. market share*

Ceramics	
AVX/Kyocera	33%
Kemet Electronics	18
Murata Erie	16
Tantalum	
Sprague/Vishay	30%
Kemet Electronics	27
Philips (Mepco/Centralab)	15
Aluminum	
Sprague Technologies	20%
Panasonic Industrial	18
Nichicon	16
Paper and film	
Sprague Technologies	18%
General Electric	17
Westinghouse	13
Variable	
Tusonix	35%
Johanson Manufacturing	20
Sprague-Goodman	14

*General overall categories only

Source: Frost & Sullivan

Tantalums get bigger by getting smaller

Surface-mount (SM) technology isn't driving only the size of components, but also their materials and technology. New York-based market research firm Frost & Sullivan predicts that SM applications will drive tantalum capacitors—the second-largest market after ceramics—from today's market of $485 million to $695 million by 1996. That jump, from 23.2% of the total capacitor market to 24.5%, might not seem like much, but in a mature market facing near-term growth in the single digits, it's worth taking a look at.

Tantalum is well-suited to follow the trend toward smaller, higher-density components because it provides high efficiency in a small size. It also withstands the high temperatures used in printed-circuit-board manufacturing. Some customers use tantalums instead of aluminum and film capacitors because of the inability of the latter two to withstand SM processes. (Some multilayer ceramics, however, are reaching the tolerance levels formerly the domain of tantalums.)

Tantalums haven't taken off in any big way for a couple of reasons—namely, their relatively large size and hefty price. By contrast, "Ceramics are coming in smaller and smaller packages, 0.08 in. by 0.05 in.," says Judy Hausman of NEC, a major manufacturer of tantalum caps. "Tantalums are now in a 0.12 by 0.06 [inch] pack, but we're pushing them to get smaller." Indeed, F&S notes that advances in molded-tantalum chip construction allow manufacturers to comply with size standards so far met only by multilayer ceramic chips.

Tantalums are pricey because they are more specialized and are polarized so they can be inserted only one way. Another reason is that their raw material costs still exceed those of other materials. "At the beginning of the decade, tantalum powder prices doubled," says NEC's Hausman. "But that seems to have come back down and stabilized."

Specialty passives distributor Projections Unlimited Inc.'s president David Herring reports that tantalum and ceramic chips account for half of his entire business. "Everyone will eventually catch up to that," he says. "We try to be on the leading technology edge. But chips are becoming commodity products." ☐

Kuhl. He adds that another customer, Ford Motor Co., wanted another kind of EDI based on automotive-industry standard bar codes.

Consolidation within the capacitor industry itself has become a competitive equalizer, with a few big global players competing for most of the available businesses. One customer that manufactures globally reports his supplier roster is down from 109 to about six; of that, three suppliers get 97% of his business.

And the few competitors will remain stable. "It's getting to be less of a ball game," observes Judy Hausman, market manager for passive components at NEC Corp. in Mountain View, Calif., a major manufacturer of tantalum capacitors. "There are fewer of us, but it's gotten down to a few big players, like Kyocera/AVX, and Vishay, that won't go out of business."

STILL, NOT ALL global players have been successful at global service. "Our Japanese suppliers were giving us some problems last year in terms of supplying product. And that was a surprise, considering the Japanese market was down," says one capacitor buyer. "They were extending lead times out to 12 or 14 weeks." In some cases this was a result of foreign plants supplying their own domestic customers at the expense of overseas buyers, or inventory being tied up in transit, physically unavailable because it is being delivered by boat. In fact, adds the buyer, some of his company's European facilities were phoning home to get product from the States instead of the Far East because they couldn't get product or their delivery windows weren't being met.

The sluggish market has capacitor manufacturers trying to keep, and maybe gain, customers who award their business based on intangibles

Domestic suppliers, he adds, still stack up fairly well against competitors from the Far East. "Kemet's getting more into the ceramic business, and if they can provide the same quality and service in ceramics that they do in tantalum, they'll put some pressure on the Japanese."

The U.S. is still the single biggest consumer of capacitors, but Electronic Outlook Corp. estimates almost half of the worldwide capacitor market will originate from the Far East by 1995. And this is prompting vendors without a big presence in those markets to redouble their efforts to penetrate them. "Many multinationals have moved their assembly operations offshore, computers and peripherals in particular," says Don Alfson, president, Vishay Electronic Components/Dale, owner of Sprague's tantalum and thick-film capacitor divisions. "We don't penetrate all those markets—specifically Japan—as well as we'd like." To do so, Vishay has set up a new Pacific Rim/Asian operation charged with building new avenues for capacitor sales as well as pursuing manufacturing opportunities

SUCH A GLOBAL presence, Alfson adds, is imperative, particularly because many of those multinationals want to negotiate supplier contracts on a global basis. "They want to talk to one person, and also get one worldwide price," he says.

Even global contracts, though, have to perform on the local level. Codex, a division of Motorola, located in Canton, Mass., is part of one such arrangement. "Lead times and flexibility are critical to us, says Marci Gray, group manager for component engineering, "and we're working toward more aggressive goals than others within Motorola. We convey that to [local] suppliers on our own." Suppliers are given a six-month forecast of Codex's expected needs and are then updated at intervals during the six-month period. Based on those forecasts, suppliers are being asked to whittle lead times down from the current three weeks to two weeks by year-end, one week next year, and *one day* by 1994. That's demanding, even by Motorola's standards.

"The ability to work with us differs from supplier to supplier," Gray adds. "We have some programs in place, while other suppliers say 'We'll try.' It's certainly a differentiator in where we place our business." ☐

Distributors are seeing more capacitors

The push toward customer service in the worldwide capacitor industry is good news for distributors. In order for capacitor makers to better serve their second- and third-tier accounts—customers that don't order enough volume to deal directly with manufacturers—they're pushing more product through distribution.

About 27% of capacitor sales go through distribution, and suppliers hope to increase that to 34%, reports *Electronics Purchasing* magazine. Manufacturers find distribution sales increase their efficiency, since distributors reach a more varied customer base. "We've definitely seen our [capacitor] volume going up," says David Herring, president of passives distributor Projections Unlimited Inc. "Suppliers find it's the best way to go to market for their smaller accounts—they don't need direct salespeople out there."

The industry-wide drive toward surface-mount is also pushing more sales through distributors. A rash of small contract manufacturers—many of them distributors or affiliated with distributors—offer surface-mount capability to small shops that can't afford to switch over from through-hole assembly. "There are lots of different capacitor values on a board and a lot of different parts [besides capacitors] need to be managed, and that means lots of inventory," says Murata Erie's Tom Kuhl. "Distributors have been hungry for that." ☐

Hot DSP market tantalizes analog and digital IC makers

Both see gold in growing demand from communications, imaging, and graphics applications. Figuring out which niche to serve is the immediate challenge

By Stephan Ohr

By 1995, every time you pick up a telephone you'll be contributing to the growing market for digital signal processing chips (DSPs). Your modem, fax machine, and car phone also make use of DSP technology, or will soon. This is merely the tip of the iceberg. DSP-based voice recognition systems could replace on-line telephone operators, fax machines will send and receive in color, and video conferencing will take place at your desk.

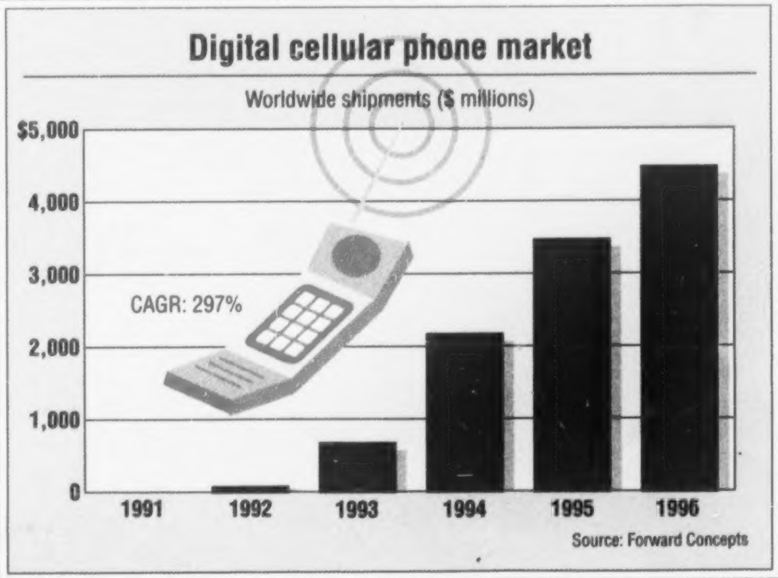
The wealth of new DSP opportunities has already stirred up a hornets' nest of activity, pitting established giants like Texas Instruments and Motorola—who honed their DSP technology through pioneering work for expensive military systems—against lean, fabless upstarts like DSP Group and Star Semiconductor, who hope to capture the emerging market for affordable DSP technology.

DSP chips accounted for some $1.1 billion in sales in 1991, according to market researcher Will Strauss, president of Forward Concepts in Tempe, Az. A 31.2% compounded annual growth rate will grow to $4.2 billion by 1996. More than 40% of this, says Strauss, is communications equipment. However, if you accept that PC-based video conferencing will account for many DSP applications under the 14% "computer" umbrella, or that all-digital telephone answering machines will account for large percentages under the 22.2% "consumer" umbrella, then the telephone-related use of DSPs may be as high as 70%.

Digital signal processing is not the same kind of processing that, say, an Intel 80386/486 applies to Microsoft Windows software or a RISC processor applies to workstation software. Rather, DSP chips manipulate analog signals or waveforms—in most cases by altering frequency content. The analog signal can be a voice or stereo music, a video signal (such as a television image going through a cable), or a radio frequency transmission. By altering its frequency content, the DSP typically filters or compresses the signal, improving its signal-to-noise ratio, eliminating distortion, or, in the case of a video image, making it easier to comprehend. In the case of audio signals, DSP techniques eliminate the hiss, clicks, and pops from old records and tapes.

In the case of high-speed modems, DSP chips shape the serial data stream so that a 9600 bit-per-second or 14.4-kbit/s digital pulse stream can be transmitted and received error-free on a narrower 3-kHz telephone line. With video image processing, DSP will compress a high-frequency video image so that it can be transmitted over lower-frequency telephone lines (albeit 64-kbit/s)—a feature that paves the way for new-generation video phones and conference systems.

Visual image processing, in fact, remains

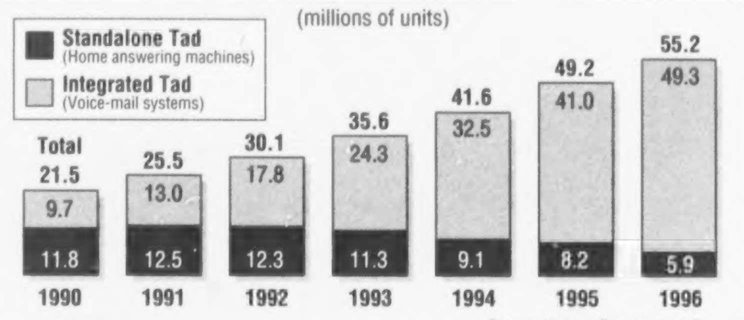


Digital cellular phone market

Worldwide shipments ($ millions)

Source: Forward Concepts

Telephone answering device market rings up increased sales



Source: Ventura Development Corp., EIA and DSP Group

among the most challenging applications for DSP chips; that is, an application which requires strong math-processing capabilities (accuracy and fast response). This is the high end of the digital signal processing market, which is split between commercial and military applications. The commercial applications include video image compression—a necessary ingredient for desktop video conferencing and video phones. The military imaging applications include visual threat identification and targeting, in which enemy objects are identified in an otherwise ambiguous visual field. DSP imaging techniques, for example, can be used to distinguish tanks or artillery from other objects in a satellite photo.

Apart from obvious differences in cost (commercial parts do not have to go through 883B screenings), commercial and military imaging applications have different processor requirements. Commercial image processing chips—like JPEG encoder/decoders—are part of the market Strauss calls "FASICs," function- and application-specific ICs. These are parts developed and optimized to perform a very specific DSP functions such as image compression. FASICs will account for some of the highest DSP market growth, says Strauss, expanding 33.1% per year from $477 million in 1991 to almost $2 billion in 1996—and that, he admits, may be very conservative. While desktop multimedia and videophone applications accounted for only a small portion of the FASIC market in 1991—3.9% (about $18 million)--this number will grow 99% per year, Strauss predicts.

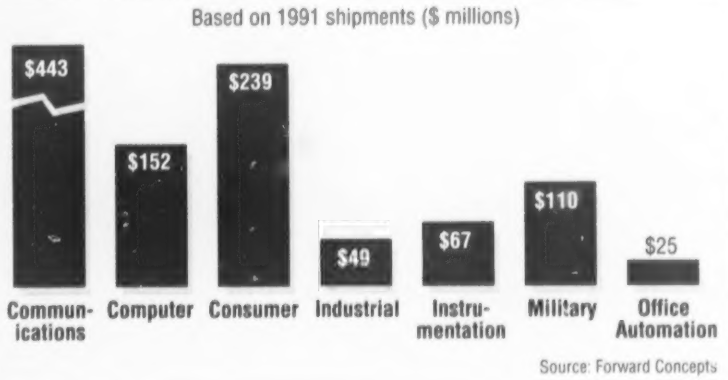
A variety of high-end DSP suppliers are attacking what may be a lucrative market for JPEG codecs. An international standard of the Joint Photographic Experts Group (JPEG) applies compression to a complex still video image to both reduce the storage space it will require on a hard disk and to reduce the cable bandwidth it requires for transmission. Because of its ability to provide very high quality reproduction and frame-by-frame video editing, JPEG is already being touted as the standard for color electronic publishing (e.g., color Postscript) and color facsimile transmission. Consequently, the field of announced JPEG products is starting to thicken. Early products by C-Cube Microsystems in San Jose and SGS-Thomson Microelectronics in Agrate Brianza, Italy, have all but been eclipsed by more recent entries from LSI Logic in Milpitas, Calif., and others. Zoran Corp. in Santa Clara, Calif., which had produced FASICs (ghost cancellation devices) for digital television, will be out this summer with an integrated JPEG codec small and cheap enough to be used in new-generation Japanese digital recording cameras. The device is a joint development with Japan's Fuji Photo Film Co. As replacements for 35mm single-lens reflex cameras (the high end of the Japanese camera market), Zoran's president, Dr. Levy Gerzberg, sees the total available market (TAM) at close to 4.2 million units—at $25 to $35 per chip.

Meanwhile, progress continues on other forms of video image compression. AT&T Microelectronics in Allentown, Pa., announced a three-chip set for multimedia conference applications based on the same technology introduced with the company's VideoPhone 2500. Array Microsystems in Boulder, Colo., previously a supplier of high-end DSP building blocks for military applications, will introduce a similar part to adapt on-the-fly to multiple compression standards. "I may need to revise my multimedia forecast upward," jests Strauss, who currently suggests multimedia DSPs will hit $250 million in 1995.

In contrast to commercial imaging applications, military applications require what Strauss calls "building block" components—numerical processors and sequencers such as ALUs, multipliers, fast fourier transform (FFT) and more discrete cosine transform (DCT) processors, FIR (finite impulse response) filters, and convolvers. He says that, while the military will account for only 10% of the overall DSP market, they will use up to 55% of the DSP building block components.

The building-block market is actually split, says Strauss, between low-end ALUs and data path chips (including address generators) and high-end, more integrated components. Low-end products, like the AMD 2903 family, accounted for $71 million in 1991 sales. Strauss sees this segment declining at a 7% annual rate, while the high-end increases at a 11.2% CAGR. Its 1991 sales were $45 million. For some suppliers, like Texas Instruments in Dallas, the military remains a good business. In 1990, TI had close to 83% of the military DSP market, contends TI's military DSP and ASIC marketing manager, Tom Smith.

Another manufacturer that seems to be doing well in military DSP applications is Intel in Chandler, Az., with its i860 "supercomputer on a chip." "Although it's not designed as a DSP," says Strauss, "it's very



New opportunities for DSP Market

Based on 1991 shipments ($ millions)

Source: Forward Concepts

efficient for certain algorithms."

Other DSP equipment manufacturers who focus on the proposed cutbacks in military budgets are beating a hasty retreat. Companies like Semetex in Los Angeles are remarketing industrial visual imaging systems once built for the military object detection techniques. In the case of Semetex, the new system is used for visual inspection of manufactured goods on a factory floor.

Analog Devices Inc. has made strong moves to distinguish itself in commercial realms. At one point in its history, as much as 70% of the company's products—which included high-precision op amps and data converters—went into military channels. Radar tracking systems using ADI 2100 and 21000 family parts are being redesigned for collision avoidance systems; military communications sets become police and fire department radios. But much more - needs to done.

To steer its 2101 family DSPs into commercial realms, says ADI product manager Tim Counihan, the company adopted what it calls a "signal computing model." Any design win for DSP must be supported by not just a programmable controller, but also by a front-end linear signal conditioning capability and an easy software programming effort. "Rather than a 'technology in search of a market,' " says Counihan, "you've got to start with an application and make sure that you have a product that does *that* job." A success story for ADI, in this regard, is a PC multimedia chip set that provides MPEG image compression, stereo audio decoding, and also serves as a fax/modem transceiver.

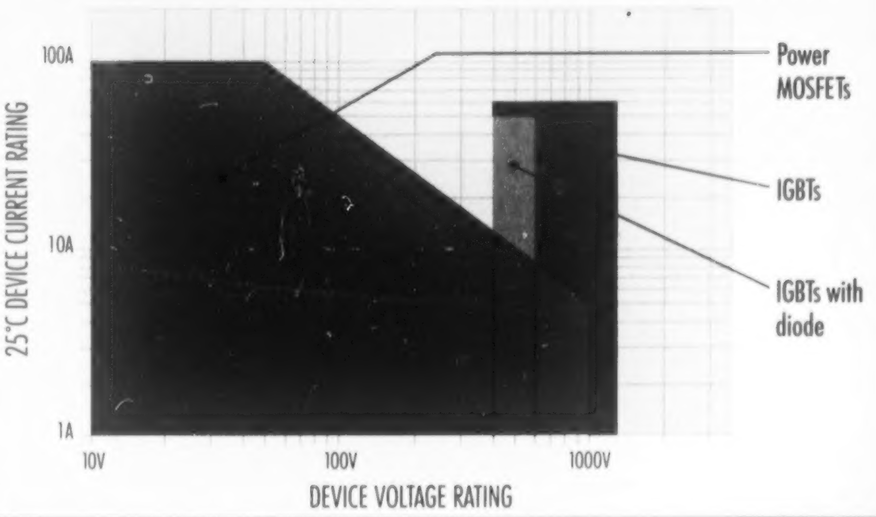
The market that has ADI and everyone else drooling is digital cellular telephone. With digital coding and compression schemes—GSM (Groupe Speciale Mobile) in Europe and TDMA (time division multiple

THIS OUGHTA START YOUR

Here's the fast way to get your motor started. Call Harris. We've got everything you need for every kind of motor control application. Including power MOSFETs, IGBTs, ultra-fast rectifiers, MOVs and IC drivers. So tap the power of Harris. Call 1-800-4-HARRIS, ext. 7009. Today.

HARRIS
SEMICONDUCTOR

HARRIS HAS YOUR MOTOR APPLICATION UNDER CONTROL



access) in the United States—mobile phone service companies can accommodate more users and provide clearer transmission lines for each one. Mobile phone installations, as a consequence, are expected to increase at a 297% CAGR. There is enormous potential in Eastern Europe, as one example, where there is currently a two-year waiting list for installation of new phone services. As Strauss quips, "They ain't got no wires—people buy cellular telephones for their desk."

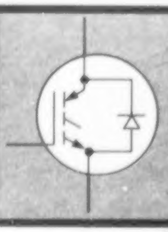
Because most cellular telephones are portables fixed at 3-watt outputs and offered to consumers, the market need is for high-transmit power, long battery life, identified as both "talk time" and "standby" life, and the ability to decode transmitter signals quickly.

A DSP user, Teknekron Communications Systems, a $44.8 million network management systems supplier in Berkeley, Calif., is developing voice compression algorithms for TDMA cellular telephone systems, in conjunction with AT&T and Mitsui Comtek Corp., the American arm of Mitsui & Co. in San Jose. Teknekron will utilize the AT&T DSP1616 devices for voice coding, says vice president Amine Haoui, although the company has also built systems in the past with the TI C51/53 (high-performance versions of the TMS320) and the Motorola 56000.

Another communications-related market that will show significant growth for customized DSP processors is consumer electronics. The two major applications are compact audio disk playback systems, and all-digital telephone answering machines. Digital telephone answering machines are based on the DSP's ability to digitize and compress a voice signal. Instead of putting the recorded voice on tape, it can then be recorded in nonvolatile memory. This, in principle, will be cheaper and more reliable than tape recording mechanisms. As replacement units, the TAM for digital telephone answering machines is currently about 25 million units, suggests Asaf Mohr of the DSP Group in San Jose—and is expected to hit over 55 million by 1996 (see Figure 4). Mohr's company develops custom chip sets for this application. Answering machine manufacturers like Phonemate and Sanyo are already customers for the $18 to $25 parts.

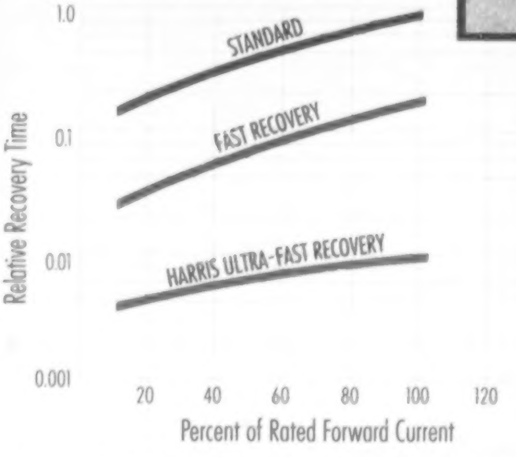
A technical advance that will aid the development of DSP FASICs is a DSP algorithm development system announced late last year by a Warren, N.J. start-up, Star Semiconductor. While it is possible to customize TI, Moto, AT&T and ADI processors for particular applications, these devices still carry the chip real estate and performance limitations of general-purpose DSP processors. Fully custom devices, on the other hand, can be expensive and difficult to develop. The Star solution combines a modifiable stream-processing architecture with easy-to-use programming tools. The brainchild of ex-TIer and modem-expert, Jeffrey Robinson, the new company has already reached $1 million in sales and is having difficulty keeping up with demand. The Star System may do for DSP chips what PLDs have done for custom logic parts: add a nice boost to an already growing market. ☐

MOTOR RUNNING



Harris IGBT/diode combinations save space by lowering part count. They're available in 3 package styles, 400V to 600V, and 6A to 24A @ 25°C.

RECTIFY WITHOUT DELAY



Harris can rectify your speed problems. Our ultra-fast rectifiers offer recovery speed that's 10 times better than the competitors'. Plus they feature low V_F, high V_R, and low I_{RM}.

PURE POWER IN MOSFETS

- Lowest $R_{DS(on)}$ available

	N-CHANNEL	P-CHANNEL
TO-220	14mΩ	65mΩ
TO-247	10mΩ	26mΩ

- Only SPICE model that operates over temperatures from -55°C to 150°C
- Only Harris provides UIS/SOA curves
- ESD rated and protected devices

TRANSIENT PROTECTION

INDUSTRY'S WIDEST VOLTAGE RANGE	INDUSTRY'S WIDEST RANGE OF PACKAGES
3.5 V dc to 6000 V ac	Radials Surface Mount Industrial high-energy MOVs

C1850-2

Don't be misled by productivity figures
PAGE 51

EB 200's return on equity was cut in half in '91
PAGE 37

How Linear Technology avoids R&D overspending
PAGE 96

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE

AUGUST 1992

15th ANNUAL ELECTRONIC BUSINESS

200
ONE
72656
F 80
161 K

Hold your breath. Profits plunged 54% PAGE 18
Restructuring: Who took the big hits PAGE 25
Every financial you could ever want PAGE 70

Electronic Business

VOLUME 18 NUMBER 11

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

AUGUST 1992

COVER STORY

FINANCE & ECONOMICS

14 **The 15th Annual ELECTRONIC BUSINESS 200**

By almost any measure, 1991 was a lousy year for the U.S. electronics industry: Profits nosedived 54% against 1990 figures—the biggest one-year drop ever—return on equity dropped by a similar amount, and hefty restructuring charges threaten to become an annual event. The good news: We got better at controlling costs, and productivity rose pretty much across the board

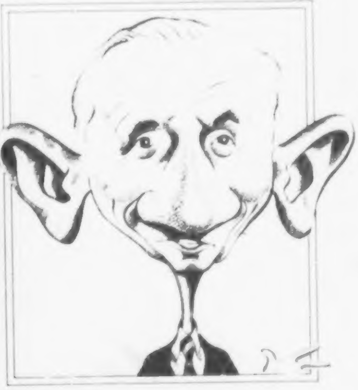
Cover photograph by Bryce Flynn

UPFRONT

Business Trends

9 A new court ruling on video-game software development could put a big chill on reverse engineering; Feds threaten hefty fines in crackdown on high-tech trade with former adversaries; Only deep-pocket vendors are likely to survive now that 'PC' means "price cuts"

PAGE 9 A California court case could lead to limits or ban reverse engineering



Maybe they were favoring one of their own, but attendees of PC Expo in June picked Ross Perot hands-down. Now what?

PAGE 57 "We often targeted our own elegant implementation of technology," admits Varian CEO Tracy O'Rourke

PAGE 65 "We didn't realize MSI Data's product line was as weak as it was," says Symbol president Martino

PAGE 96 CEO Robert Swanson of Linear Technology

FEATURES

FINANCE & ECONOMICS

THE ELECTRONIC BUSINESS 200

14 Fifteen unsettling years for the ELECTRONIC BUSINESS 200

18 Will profits ever rebound for the ELECTRONIC BUSINESS 200?

25 Sadly, 1991 was a great year to take write-offs

37 Recession, restructurings claim return-on-equity as a victim

41 Corporate liquidity is crunched

45 Is the industry growing foreign sales fast enough?

51 How reliable are those productivity numbers?

57 Going back to basics pays off for Varian

65 Tough acquisition was worth it for Symbol Technologies

70 The ELECTRONIC BUSINESS top 200 electronics companies

81 Every industry segment tells a story

83 Industry segments

91 Notes to the 200

93 Alphabetical index

BUSINESS STRATEGY

96 How Linear Technology gets the biggest bang for its R&D bucks

When it comes to R&D budgets, says CEO Robert Swanson, more isn't necessarily better. In this interview, Swanson explains how he applies simple but sound management principles to help Linear skim the cream off its new-technology ideas

101 A listing of the top 100 R&D spenders

PRODUCT DEVELOPMENT & MANUFACTURING

105 Contract manufacturing looks to higher quality, lower costs

Experts disagree on whether quality brings in revenue. Still, the drive toward the Baldrige and ISO 9000 certification may be the engine for growing the industry by 15% this year

109 A listing of contract manufacturers

DEPARTMENTS

My View *By Frank Burge, publisher*

119 About making a difference. And the other 94%

Company Index

122 Companies covered in this issue

Advertiser Index

124 Advertisers covered in this issue

Viewpoint *By John Russell, editor*

126 Let's rewrite the contract between business and ourselves

bucks if their products turn up where they're not supposed to be.

Last November, the DOC established new sentencing guidelines, the most significant of which dictates higher fines for exporters that do not establish programs for tracking their controlled product exports. The idea is to prevent high technology from being acquired and used by blacklisted governments and terrorist organizations that might develop weapons of mass destruction, among other things. Blacklisted countries include Libya and Iraq, as well as Pakistan and even China.

"The problem for a manufacturer is that it can be held responsible for, say, a chip it makes that winds up in a country that is on the DOC's blacklist. Companies now find themselves subject to very heavy fines for not paying attention to export tracking requirements and the responsibilities that go with them," says Bill Chastka, president of consulting firm Washington Resources International Inc.

Although U.S. companies can't guarantee their products won't end up in blacklisted countries, the DOC is holding them accountable for having export-tracking systems in place. "It's a difficult thing to do," says Compaq Computer export attorney Joe Tasker. "There's only so far you can go to make inquiries [down the export distribution channel]."

Unfortunately, the ramifications of the new sentencing guidelines are still unclear. "It's become a matter of [companies] proving they have an effective program in place that makes everyone in the chain of distribution accountable for where products end up," says Chastka.

DEC computers, for example, were recently discovered in an undisclosed blacklisted country. The DOC investigated, and under the new rules, DEC was fined $2.4 million. That was only a fraction of the fine that could have been levied had DEC not had an accountability method in place. PC clone maker Everex Corp. was similarly fined $500,000.

The process relies too much on trust, says Opus Systems Inc. CEO Jim Katzman. Companies may sign an agreement with the clause, but either through blatant disregard or (more often than not) ignorance, they end up shipping the product to forbidden destinations.

"A lot of companies are in trouble over this one," says Chastka. "They have to educate their resellers and distributors, or they are going to get burned."

—David Webb in San Jose

Perot was the choice of PC Expo goers

Perot	42%
Clinton	22
None of the above	19
Bush	17

Dorothy Ahle

Ross Perot may be out of the presidential race, but he's taking the hearts and minds of the PC industry with him. Perot ran away with the lead in a straw poll of 1,500 attendees at PC Expo in New York in June, three weeks before the Texas billionaire dropped out of the race. The poll was conducted using the trade event's ShowNet computer-based demonstration network. —R.W.

MARKETS

Who will remain now that "PC" means "price cuts"?

What will it take for vendors to survive the PC industry price war? Efficient operations, solid service and support—but perhaps most important, lots of cash.

"Those who will be hurt most are those who don't have very deep pockets," says Bruce Stephen, analyst for International Data Corp. "Many vendors will cut prices, but sooner or later, some will have to close their doors."

By abandoning its Rod Canion-era strategy of selling only top-of-the-line PCs with fat profit margins, Compaq has removed the price umbrella under which hundreds of clone makers flourished. "Our focus is now on market share and revenue growth," Compaq chairman Benjamin M. Rosen said in June while introducing Compaq's ProLinea line of low-priced clone killers.

"Compaq is trying to be the American Airlines of the PC industry," says senior analyst William Bluestein of Forrester Research Inc., referring to fare cuts that led to an airline industry price war.

An apt analogy. In the wake of the Compaq announcement, virtually every PC vendor slashed its prices, while Dell Computer Corp. and Everex Systems Inc. responded with their own low-cost PC lines.

Smart vendors aren't focusing just on price. In a survey of PC users conducted by BIS Strategic Decisions, 79% said service and support were factors in their buying decision. Some vendors are taking that advice to heart. Epson America is offering on-site service for PCs under warranty. Almost overlooked in Dell's announcement of its low-priced Dimension PC line was a plan to expand its support services.

As with the airfare war, the PC price war will have its casualties. Northgate Computer has already sold out to Everex. Analysts were predicting Zeos's first-quarter $1.9 million loss would grow in its June quarter. Packard Bell put on hold its plans to go public. IDC's Stephen expects a number of weaker players—which he declined to identify—to either go out of business, be acquired, or retreat to other lines of business.

—Rick Whiting

15th ANNUAL
ELECTRONIC BUSINESS

These were the giants of 1978–our first top 100 list

1. IBM
2. Western Digital
3. ITT
4. General Electric
5. Honeywell Inc.
6. RCA Corp.
7. GTE Corporation
8. Sperry Rand Corp.
9. Xerox Corp.
10. Litton Industries Inc.
11. Hughes Aircraft
12. Rockwell International
13. Burroughs Corp.
14. Texas Instruments Inc.
15. Motorola Inc.
16. Raytheon Co.
17. NCR Corp.
18. Westinghouse Electric Corp.
19. United Technologies Corp.
20. Control Data Corp.
21. Hewlett-Packard Co.
22. North American Philips Corp.
23. Digital Equipment Corp.
24. TRW Inc.
25. Bendix Corp.
26. Zenith Radio Corp.
27. General Motors Corp.
28. Grumman Corp.
29. The Boeing Corp.
30. Avnet
31. 3M
32. Martin Marietta Corp.
33. The Singer Co.
34. McDonnell Douglas Corp.
35. Northrop Corp.
36. Harris Corp.
37. AMP
38. General Instrument Corp.
39. Tektronix
40. Teledyne Inc.
41. Fairchild Camera/Instrument
42. Ford Motor Co.
43. Lockheed Aircraft Corp.
44. National Semiconductor
45. Memerox Corp.
46. General Dynamics Corp.
47. Varian Associates
48. Corning Glass Works
49. Addressograph-Multigraph
50. Perkin-Elmer Corp.
51. P.R. Mallory & Co.
52. Ampex Corp.
53. Beckman Instruments Inc.
54. E-Systems
55. Bunker Ramo Corp.
56. Eltra Corp.
57. Lear Siegler Inc.
58. Schlumberger Ltd.
59. Data General Corp.
60. The LTV Corp.
61. Siemens Corp.
62. North Electric Co.
63. Intel Corp.
64. Emerson Electric Co.
65. Cutler-Hammer Inc.
66. Eastman Kodak Co.
67. Matsushita Electric Industrial
68. General Cable Corp.
69. AMF Inc.
70. Leeds & Northrup
71. Textron Inc.
72. E.I. DuPont De Nemours
73. The Foxboro Co.
74. Sanders Associates Inc.
75. Mohawk Data Sciences Corp.
76. Bally Manufacturing Corp.
77. Cramer Electronics Inc.
78. Reliance Electric Co.
79. Soundesign Corp.
80. CTS Corp.
81. Sybron Corp.
82. Management Assistance Inc.
83. Data 100 Corp.
84. Storage Technology Corp.
85. Tracor Inc.
86. Oak Industries Inc.
87. Gould Inc.
88. The Telex Corp.
89. California Computer
90. Fischer & Porter Co.
91. Cincinnati Milacron Inc.
92. Bulova Watch Co.
93. Itek Corp.
94. Pitney-Bowes Inc.
95. Lloyd's Electronics Inc.
96. Conrac Corp.
97. Victor Comptometer Corp.
98. Bourn Inc.
99. Datapoint Corp.
100. Dynascan Corp.

Source: ELECTRONIC BUSINESS

Fifteen unsettling years for the ELECTRONIC BUSINESS 200

It's hard to believe, but the ELECTRONIC BUSINESS 200 celebrates its 15th anniversary this year. Led by our finance editor Linda Stallmann and consultant Jerry Wasserman from Arthur D. Little, we published the first list of top 100 electronics companies in February 1978. With IBM and AT&T's Western Electric on top, all told, the 100 sold $83 billion worth of electronics in that first year.

Those *were* the days. On average, a company in 1979's top 100 raked in a 5.8% return on sales, versus only 1.9% this year. Then, we worried that Fairchild, RCA, and Texas Instruments were making unwise decisions about something called seat belt interlocks, and we worried that the industry wasn't spending enough—3% of sales—on R&D. Still, compared with the industry's dilemmas lately, no one was really worrying too much back then.

In 1980, we announced the arrival of the microprocessor. Tandy and Northern Telecom joined the list, and Fairchild became subsumed within Schlumberger. By 1982, as Apple, Commodore, and Rolm quietly boarded the list, we heralded the arrival of the $2 billion desktop computer market, speculating it would rise to $14 billion by mid-decade. It's $80 billion now.

By 1984, with $318 million Compugraphic in last position, the 100 looked a bit top heavy. So, with the aid of a PC that then-publisher Vic Drumm bought with his credit card, we expanded the list. Thus, the first 200th company—$104 million Keytronic—arrived. Now-famous Compaq and Cray Research made the expanded 200 too, as well as unknowns like Kratos, Plantronics, and Vernitron. Today's 200th company, Integrated Device Technology, is $100 million bigger than Keytronic was in the 1984 listing.

The bubble burst in 1986 and we named that year's 200 "a tale of toil and turmoil." Merger mania took over as GE acquired RCA, GM bought Hughes Aircraft, and Burroughs merged with Sperry to become Unisys. In 1987, with Lotus too big to ignore, we added software companies. That's when Sun Microsystems catapulted into the list for the first time to position #93.

By 1988, we foolishly suggested the mature electronics industry was "finally settling down." But with Chips and Technologies and Dell Computer making the list one year later and Sun still growing at a breathtaking 161% five-year compounded annual rate, it became apparent that "settling down" was not a notion one could apply to this industry.

This year, the 200 has sold $367 billion worth of electronics products and services. Who knows what the next 15 years will bring.

—E. B. Baatz

Electronic Business
200
Exclusive financial analysis of the leading electronics and computer companies
Electronic Business
Electronic Business
200
1986
Electronic Business
200
200
Electronic Business
200
THE TOP 200 U.S. ELECTRONICS COMPANIES
Electronic Business
THE ELECTRONIC BUSINESS 200
THE LARGEST U.S. ELECTRONICS COMPANIES
Electronic Business
THE ELECTRONIC BUSINESS 200
THE LARGEST U.S. ELECTRONICS COMPANIES

Will profits ever rebound for the ELECTRONIC BUSINESS 200?

Blame the recession, blame restructuring, but the collective profits of the 200 largest electronics companies bombed 54% last year, the biggest one-year drop ever

By Linda Stallmann and E. B. Baatz

ELECTRONIC BUSINESS 200
YEAR-IN-REVIEW

You thought 1988, '89, and '90 were lean years for the electronics industry? The financial performance for the top 200 electronics companies in 1991 makes those years look like a picnic. Last year's 54% decline in aggregate profits was far worse than the 1985-86 recession, when wild inventory swings led to a 20%-plus drop in the top 200's total profits for two years in a row. There is a silver lining, however. Last year's pains pave the way for at least some modest gains this year.

Here are the grim facts as gleaned from ELECTRONIC BUSINESS's annual reading of the financial reports for the top 200 largest publicly owned U.S. electronics companies:

- Sales growth slowed to a trickle. Revenue from electronics-related products and services grew just 1.4% during the 12 months of 1991 to $367.5 billion, the slowest annual gain ever.
- Stockholders suffered. Return on equity averaged only 5.8% last year, a shock to an industry that had never before delivered a return to its stockholders of less than 10%.
- Cost cutting didn't help. The top 200 ditched 4% of its work force, yet productivity gains, as measured by a weighted average of revenue per employee, remained mired at only 4.7%, less than half the encouraging gain of the year before.
- Manufacturing costs were stuck. As a share of total sales, the cost of goods sold for the 200 remained stalled at 60.9%, unchanged from the year before. That means the industry's many quality programs haven't yet driven costs down.

What happened? The recession that most economists termed *mild* certainly added to the industry's woes. Worse, though, was the impact of massive corporate restructurings by the likes of IBM, Digital Equipment, Unisys, and Texas Instruments. These four alone accounted for 26% of the total electronics-related revenue generated by all 200 companies, and their restructuring charges took a big bite from the bottom line. Together, the faltering four lost a breathtaking $3.2 billion.

Unfortunately, the red ink seemed to flow nearly everywhere last year; smaller companies were just as likely as the billion-dollar giants to have suffered losses. A total of 50 companies reported a net loss in calendar 1991, up from 37 the year before and 43 in 1985. Excluding companies with big electronics divisions such as AT&T and Allied Signal, for which only total corporate net income is reported, the pure-play electronics companies lost a combined $5 billion last year, compared with losses of only $3.5 billion in 1989 and $1.9 billion in 1985.

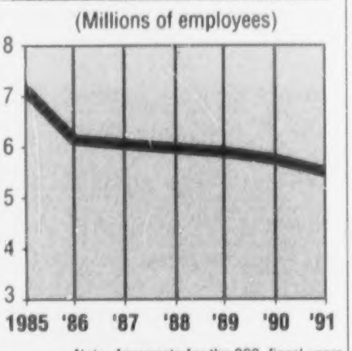
As a result, profitability slumped to a new low. Average net profits as a share of total revenue stood at a flat 2% last year. Sure, profitability had been slipping gradually from a peak of 5.9% in 1987 to 4.4% in 1990, but normally the high-flying newcomers to the 200 and the old dependables like most-profitable Microsoft and eighth-most-profitable Intel had offset the poor performers. Newcomers Syntex, Adobe Systems, and Cabletron Systems all contributed with profit-to-sales ratios of above 19%. Nonetheless, profitability for half of the top 200 wallowed below 3.3%.

Poor financial performance last year was more than just the result of a mild recession and maturing industry. Fact is, the entire electronics industry has been coping with big changes. Digital Equipment and IBM may be struggling with the move toward open-standard systems, but the overriding challenge for many others on the 200 has been simply learning how to respond to their customers faster and more effectively. Technology no longer pushes sales the way it did in the '80s. While "customer satisfaction" and "customer focus" were favorite buzz phrases in last year's batch of annual reports, shifting from a technology-focus to a customer-focus takes much more than mere words.

Case in point: The globalization of the top 200 U.S.-owned electronics companies continues unabated. For every $1 in sales rung up by the average electronics company, foreign customers contributed over 34 cents to the till in fiscal 1991. For some, the stampede to foreign markets helped produce stellar results. Advanced Micro Devices increased its foreign sales 84% from fiscal 1990 to 1991 and Dell Computer raked in 73% more revenue from abroad. Even connector maker Molex, which made over 70% of its sales from overseas in 1990, managed to grow foreign sales a solid 27% last year.

For others, growing foreign sales hasn't been so easy. Nearly a quarter of the 200 saw foreign sales fall in fiscal 1991. From IBM, whose foreign sales inched downward 3.6%, to Integrated Device Technology, whose sales to Japan and Europe slumped 46%, the lesson is that having customers in another country is no panacea.

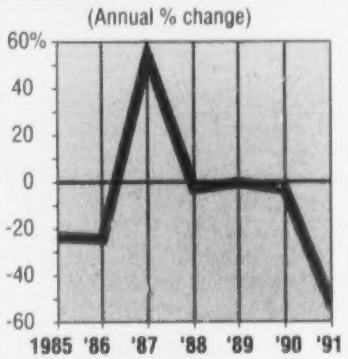
Employment keeps falling



Note: Aggregate for the 200, fiscal years

Source: ELECTRONIC BUSINESS

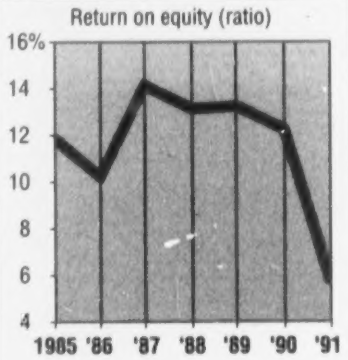
Profits *really* plunge



Note: Aggregate for the 200, calendar years

Source: ELECTRONIC BUSINESS

And stockholders suffer



Note: Average for the 200, fiscal years

Source: ELECTRONIC BUSINESS

Even though the dismal data dominate, some positive statistics—capital spending, R&D, and debt—are hidden within the 200 database. They provide a glimmer of hope because these numbers represent an investment in the future.

Despite obvious pressures to deliver to the bottom line, the 200 maintained a fairly high level of capital spending. The ratio of capital expenditures to net cash flow after dividends jumped to 120 in fiscal 1991. This ratio indicates how the industry is using internally generated funds to support capital spending. A ratio below 100, where it had languished for five years, is considered bad news.

Although last year's swing in the ratio of capital spending to cash flow was due to a decrease in cash flow and *not* to an increase in capital spending, it is clear that electronics executives have been unwilling to jeopardize capital investments despite recessionary pressures. The real test, of course, will be how well capital spending holds up this year.

The top 200 companies devoted more resources to research and development as well. R&D costs as a share of revenue rose from 5.2% on average in fiscal 1990 to 5.5% in 1991. That's back on par with R&D costs in 1989. If U.S. companies are going to compete globally, much as stockholders may bemoan the lack of dividends, then this ratio will most likely have to rise even higher in the years ahead. One example is DSC Communications. In spite of its restructuring woes and the fact it experienced a sig-

Composite performance of the ELECTRONIC BUSINESS 200

Calendar years	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
Electronics sales ($ billions)	$279.2	$299.2	$327.7	$340.8	$362.3	$367.5
Total sales ($ billions)	$641.7	$689.7	$774.5	$814.9	$865.5	$876.4
Net profits ($ billions)	$26.7	$41.0	$39.7	$39.4	$38.0	$17.6
Fiscal years*	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
Return on equity	10.2%	14.1%	13.1%	13.2%	12.2%	5.8%
Return on investment	7.2%	10.1%	7.2%	6.7%	5.7%	3.1%
Cost of goods sold/sales	63.7%	61.5%	58.6%	63.4%	60.8%	60.9%
R&D/sales	5.0%	5.2%	5.1%	5.5%	5.2%	5.5%
Sales per employee	$102,348	$113,533	$128,756	$133,941	$150,010	$157,106
Net profits per employee	$4,266	$6,662	$6,646	$6,761	$6,675	$3,334
5-year compounded annual growth rate:						
Sales	8.2%	10.7%	11.5%	7.7%	9.1%	7.9%
Net profit	4.0%	13.9%	8.3%	3.3%	5.4%	5.4%
Capital outlays to net cash flow after dividends	97.9%	73.9%	83.8%	95.0%	98.9%	120.4%
Debt to capital	29.9%	28.2%	45.3%	49.1%	53.2%	47.2%
Foreign sales/total sales	25.4%	24.9%	31.5%	32.3%	33.6%	34.3%

*Weighted average

Source: ELECTRONIC BUSINESS

nificant net loss last year, the company still managed to increase R&D spending 23% and R&D as a share of its revenue rose to 13.8%.

The industry's debt burden also improved significantly between fiscal 1990 and 1991. From a weighted average of over 53%, the debt-to-capital ratio for the top 200 dropped five points. Although this ratio is skewed—it includes debt carried by companies with substantial financing operations, such as Ford Motor and Westinghouse Electric—the median debt-to-capital ratio also fell. In 1990, half of the top 200 electronics companies had a debt ratio above 30.4%. Last year, the midpoint slipped to 27.2%. Two companies—Bolt, Beranek and Newman and International Rectifier—drew down debt faster than all others, from more than 67% and 87% of capital to 6% and 13%, respectively.

It's almost a mathematical law: As the electronics industry gets bigger, sales and profits growth are bound to slow. To make it onto the ELECTRONIC BUSINESS 200, a company had to make $204 million in revenue last year. In 1985, when IBM was a mere $50 billion company and before Sun Microsystems had gone public, the "entry fee" was only $123 million.

Despite the forces of maturation, the newcomers to the list add a dynamic, competitive edge. This year's new arrivals include five that enjoy the highest five-year compounded average growth rates: Zeos International (186%), SynOptics Communications (168%), Cabletron Systems (115%), Advanced Logic Research (109%), and Read-Rite (103%). Even more interesting, three old-timers continued to defy the laws of big numbers: Sun Microsystems, Oracle Systems, and Teradata (subsequently acquired by NCR) all clocked in with five-year growth rates over 70%. While the top 10 may falter again this year, look to the nimble newcomers to push 200 profits up again soon. ☐

This year's ELECTRONIC BUSINESS 200 is available on disk. For information, call (617) 558-4257.

Inside the EB 200

Restructuring .... page 25
Return on equity .... page 37
Liquidity .... page 41
Foreign sales .... page 45
Productivity .... page 51
Most improved company
  More than $1 billion .... page 57
  Less than $1 billion .... page 65
Main tables .... page 70
Segment analysis .... page 81
Segment tables .... page 83
Notes to the EB200 .... page 91
Alphabetical index .... page 93

Sadly, 1991 was a great year to take write-offs

The list of companies that took huge one-time restructuring charges last year reads like a Who's Who of the electronics industry. Will the list get longer yet?

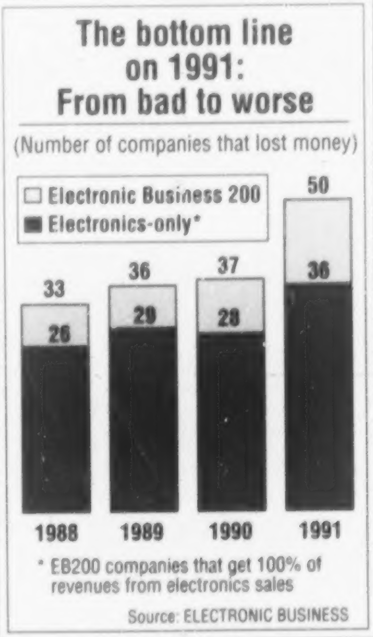
By Peter Burrows

ELECTRONIC BUSINESS 200 RESTRUCTURING

A lousy economy and rapidly changing business models forced many of ELECTRONIC BUSINESS's top 200 companies to bite the bullet on non-productive units and dead-end businesses last year. The big question is whether the worst is over, or if we are entering an era in which hefty restructuring charges become a familiar fact of life.

Consider 1991's frightening record. Blue-chippers such as IBM, Digital Equipment, and National Semiconductor took huge one-time charges to downsize their work forces, refocus on core businesses, and adjust to the more open, services-heavy business models of the 1990s. Hotshots from the 1980s such as Compaq Computer, Apple Computer, and Mentor Graphics took one-time hits to bring their cost structures in line with the slower growth expected in the 1990s. Perennial restructurers such as Unisys, Wang Laboratories, Texas Instruments, and Control Data continued to lay-off employees, sell off assets, and scale back product lines.

Such restructuring contributed greatly to what was a thoroughly dismal year for the industry. In aggregate, the number of companies on the EB 200 list that lost money rose to 50 in 1991, from 37 the previous year. For the 36 pure-play electronics companies that made this losers list, total value of losses rose to $5 billion from $2.2 billion. The industry also shrank by 90,000 jobs, according to the American Electronics Association, making it the third straight year of decline.


The bottom line on 1991: From bad to worse

(Number of companies that lost money)

* EB200 companies that get 100% of revenues from electronics sales

Source: ELECTRONIC BUSINESS

Most of the damage can be traced to the monstrous one-time charges taken by the large computer makers, including IBM's $3.4 billion, 29,000-person lay-off; $1 billion-plus charges from Unisys and DEC; and $100 million-plus write-offs from TI, Apple, Wang, Compaq, and National Semiconductor. In fact, the four top restructurers—IBM, DEC, Unisys, and TI—were responsible for 64% of the losses of pure-play electronics companies for the year.

The pain was not confined to the big boys, however. The broad, persistent recession compelled executives throughout the EB 200 to restructure. An example is Augat Corp., a $280 million supplier of interconnect products that took a $22 million charge to reduce its production capacity by 20% in 1991. "We've been running at about 60% capacity for some time, both because of the recession and because of the productivity gains we've been able to make, and we just don't see how that is going to improve in the next two or three years," says CEO Marcel Joseph.

One key problem is the worldwide nature of the recession: This time around, there has been no safety valve of overseas sales to prop up struggling operations.

But the recession was not the only reason for the long list of restructurings in 1991, however. A number of pressures combined to make it an excellent year to cut one's losses:

- **Computer price wars.** Steadily falling prices for powerful microprocessors and memories and the emergence of high-volume, mass-distribution channels for computer sales sent tremors through an industry that has long been focused on high performance, proprietary technology, and direct sales. As the cumulative bite of the gnats in the second- and third-tiers of the industry began to draw real blood in 1991, industry leaders such as IBM, Compaq, and Apple were compelled to adjust and attack the low-end mass market—a strategy that requires new distribution strategies and much leaner cost structures.

Don't be surprised by continuing reports of billion-dollar write-offs

- **Accounting changes.** Many companies chose to come into compliance with the Financial Accounting Standards Board's standard No. 106, which requires companies to account for post-retirement benefits upfront rather than on a pay-as-you-go basis. This must be done by 1994 for U.S.-based operations and by 1996 for overseas operations. Although most companies will continue to pay actual dollars when the benefits are actually incurred, having to set aside a cash fund makes for a big hit to the balance sheet that Wall Street is unlikely to dismiss altogether. IBM, for example, had to take a $2.26 billion charge in the first quarter charge to satisfy this requirement.
- **Currency fluctuations.** The ups and downs of both the yen and the deutschemark in 1991 played havoc with finance departments, causing unexpected losses for some global U.S.-based companies. DEC, for example, claims it lost $150 million to $200 million in exchange-rate fluctuations alone.

Corporate psychology also played a role, some say. With bottom lines already in disarray, companies simply saw less downside to playing it straight with Wall Street. "Whether you take a charge of $100 million or $125 million, you're not going to earn any brownie points either way," says George Siboni, director of KPMG Peat Marwick's high-technology practice. "Once you've swallowed the bitter pill, you might as well cut deep enough to ensure you don't have to swallow it again any time soon."

Indeed, many companies seem to have cut deeper than was immediately necessary. DSC Communications, a $460 million communications maker in Plano, Tex., took a $48 million charge to reduce its work force by 20%—despite having the wherewithal to increase R&D spending by 18% in an effort to keep pace technologically through these difficult times.

But was it enough? With the weak recovery doing little to boost revenues or profits, many industry observers predict a continuing cycle of morale-draining, strategy-snuffing cutbacks.

Some examples of this already exist, especially among the industry's upper ranks. Saddled with sprawling, vertically oriented organization charts and high cost structures—and sometimes progressive no-layoff policies—

Biting the bullet–big time

	One-time charges		Reductions in employment	
	($ millions)	(% of 1991 sales)	(employees)	(% decline from 1990*)
IBM	$3,400	5%	28,893	8%
Unisys	1,200	14	15,000	20
Digital Equipment	1,100	8	3,000	2
Texas Instruments	240	4	7,379	10
Apple	224	4	96	1
Wang	222	11	3,092	16
National Semiconductor	120	7	2,900	9
Compaq Computer	135	4	1,600	14
Western Digital	82	8	867	11
DSC Communications	48	10	781	19
Everex	36	8	596	23
Savin	33	11	864	42
Sprague	33	11	3,076	77
Mentor Graphics	27	7	309	15
Augat	22	8	NA	NA
Sequent	22	10	400	30

Fiscal year 1991 NA=Not applicable
* % of total work force

Source: ELECTRONIC BUSINESS and company reports companies such as IBM, DEC, and TI are struggling to get ahead of the downsizing curve. DEC, which perhaps best embodies this trend, has already announced its intention to take another $1 billion-plus charge and cut another 10,000 to 15,000 employees from its rolls in its fiscal 1992, even though it took a $1.1 billion charge and laid off 7,000 employees in fiscal 1991. (It added 4,000 employees due to an acquisition as well.) The company lost $404 million through the first three quarters of this year.

Top ten losses for 1992

($ millions)

Company	Net loss	Rank
Unisys	$1,393	9
Digital Equipment	864	4
IBM	564	1
Texas Instruments	409	10
Wang	373	40
National Semiconductor	150	44
DSC Communications	108	101
Savin	97	139
Western Digital	96	67
Borland International	75	110

Others, such as Control Data and Prime Computer, have gone a step further by deciding to once and for all end the vicious cycle of recurring restructuring that has plagued them over the past decade or so. Both recently took hefty charges to break off their older hardware units so as to focus more on their lucrative software and services divisions. Both companies are reportedly seeking investors to take these erstwhile names in computer history off their hands altogether.

Getting in front of the restructuring curve and staying there are two different things

There have, nonetheless, been some restructuring success stories. Unisys, for example, seems to have finally turned the corner after three straight years of $100 million-plus special charges. It enjoyed back-to-back profitable quarters for the first time since 1988 after taking a $1.2 billion charge last June, and has winnowed the $4 billion debt from the Sperry Corp. merger with Burroughs Corp. in 1986 down to less than $400 million at the end of 1991. Chief executive and chairman James Unruh expects the company to make money this year.

The company did this by setting 14 "turnaround teams" loose to find sources of cash and improve financial management. These teams generated over $1 billion in cash, CFO George Robson recently said, much of it through the sale of its Timeplex networking division, various real estate holdings, and other assets. All told, the company has slashed about 15,000 jobs, closed seven plants, and removed 20,000 items from its product catalog since late 1990.

National Semiconductor may be another success story in the making. The company took charges of $120 million in 1991 and $149 million in the first quarter of this year to consolidate its manufacturing and abandon certain cutthroat markets, such as high-speed SRAMs. Since then, it has strung together three quarters of profits. The $27.5 million profit in the fourth quarter ended May 31 was the company's best in five years.

Still, getting in front of the restructuring curve and staying there are two different things. "We believe strongly that you've got to get out in front and do some restructuring every day," Unisys's Unruh pointed out to financial analysts earlier this year. "Because the margins of our business . . . are going to continue to get thinner, we'd better stay in front of this reality and cut those costs."

AS A RESULT, don't be surprised by continuing reports of billion-dollar write-offs and three-, four- or five-digit layoffs. With profit margins shrinking and business models converging, the trend toward big one-time charges has certainly not yet run its course. "Our company has done all the restructuring I can foresee for the next four or five years," says Augat chief executive Joseph. "But many of our competitors and customers have yet to face reality, and it will take anywhere from 12 to 24 months for things to settle down."

Indeed, if Joseph is correct, many electronics executives will be forced to learn more about the art of restructuring—a phase of management for which the industry has had limited experience.

"My most scathing indictment of the electronics industry is that they have very few older employees who have been through the whole roller-coaster ride," says Kathryn Rudie Harrigan, professor of strategic management at Columbia Business School. "By and large, the industry has ignored its bad times by laying off its older workers, but now it's in for a real cold shower." ☐

Recession, corporate restructurings claim ROE as a victim

For stockholders in the electronics industry, 1991 was the pits as sagging profits slashed return on equity

By Rick Whiting

ELECTRONIC BUSINESS 200 RETURN ON EQUITY

Return on equity among the ELECTRONIC BUSINESS 200 plummeted to 5.8% in fiscal 1991 from 12.2% in fiscal 1990. Tne villains? The recession, for one, which slashed the 200's total net profits by 54% to $17.6 billion, and the wave of corporate restructurings, which resulted in write-offs against earnings.

A poor return on equity, or ROE—describing net income as a percentage of total equity—can depress stock prices, making it harder for companies to raise money through new stock offerings, and even making the company a tempting takeover target.

The good news is that observers expect ROE to rebound this year as the economy improves. After shedding thousands of employees and shutting down unprofitable operations, electronics companies are leaner and meaner and have lowered their break-even point.

"The economic recovery should show up even stronger in the ROE calculation," says Rick Martin, an analyst with The Chicago Corp. securities trading firm.

Sequent Computer Systems Inc., for example, saw its ROE drop from 9.7% to minus 32.6% in fiscal 1991 when the Beaverton, Ore., computer maker suffered a $48.7 million loss on a 14% drop in sales—much of that due to reduced sales to Unisys Corp., Sequent's major reseller. In response, Sequent cut about 25% of its 1,700 employees and took restructuring charges of $22.2 million. "Profitability is back on track, and we have every intention of getting our ROE back to where it was before," says Robert Gregg, CFO and treasurer.

At some companies, however, the restructurings and resulting slippage in ROE follow efforts to overhaul outdated corporate infrastructures, slash bloated payrolls, and stay competitive in the face of industry trends. Digital Equipment Corp., which took restructuring charges of $1.1 billion in fiscal 1991 as it closed plants and cut employees, saw its ROE drop from an already meager 0.9% in fiscal 1990 to negative 8.1% last year.

While old-guard companies such as DEC and IBM struggled with ROE in fiscal 1991, a new wave of companies in software, peripherals, and communications dominated the ELECTRONIC BUSINESS 200 ROE list. Microsoft Corp. and Borland International Inc. both came in with ROE above 30%, for example, as did disk-drive maker Quantum Corp. Read-Rite Corp., which develops thin-film components for disk drives, ended fiscal 1991 with an ROE of 51.2%.

In terms of ROE, fiscal 1991 was kinder to some segments of the electronics industry than others. Software companies did best among the ELECTRONIC BUSINESS 200, although the average 16.3% ROE was down from 19.0% the year before. PC and workstation vendors reported a respectable average 11.1% ROE, but not as good as the 21.9% ROE in 1990. Peripheral makers, on the other hand, saw their average ROE plunge from 16.3% in 1990 to a paltry 2.4%. And things only got worse for minicomputer manufacturers, whose average return on equity dropped from minus 7.2% in 1990 to minus 9.2% last year. ☐

Return on equity

The top five		200 rank
Polaroid	88.5%	112
Read-Rite	51.2	192
Reliance Electric	50.7	105
Syntex	42.2	197
Microsoft	34.3	38
Median for the 200	9.1%	
The bottom five		
Emerson Radio	-1,335.1%	79
Wang Laboratories	-717.1	40
Tandon	-98.7	102
Archive	-94.4	130
Western Digital	-72.5	67

Source: ELECTRONIC BUSINESS

Corporate liquidity is crunched

Despite that, R&D spending probably won't slow

By Rick Whiting

ELECTRONIC BUSINESS 200
LIQUIDITY

Recessions are brutal on corporate liquidity. Inventories pile up as sales slow. Receivables stretch out as customers take longer to pay their bills. All the while, companies continue to burn cash unless expenses are quickly brought to heel. Liquidity for the ELECTRONIC BUSINESS 200, as measured by the ratio of current assets to current liabilities, averaged 1.44 in fiscal 1991, a relatively poor performance given that most analysts consider 2-to-1 a healthy "current ratio." These statistics include auto makers and companies with financial service and credit operations, which skews the liquidity picture.

Companies facing a liquidity crunch often delay capital equipment purchases, take longer to pay their bills, and cut spending for research and development, effectively mortgaging the company's own future. Last year, capital spending by the top 200 did decrease slightly while R&D as a percentage of sales actually increased.

The recession strained the liquidity of even financially strong companies. Despite a 27% sales increase in fiscal 1991, Cypress Semiconductor Corp.'s liquidity ratio slipped to 3.45 from 3.63 a year earlier when the sluggish economy slowed the San Jose chip maker's sales growth in the second half of the year. Although 3Com Corp. of Santa Clara, Calif., reported a respectable 3.05 current ratio for fiscal 1991, that was off from the previous year's 3.89 because of a 5% dip in 1991 sales.

Not all the liquidity problems could be blamed on the recession. Some suffered as they fought to adjust to long-term changes in the industry. For example, IBM's current liabilities increased to $33.6 billion from $25.3 billion a year earlier. Big Blue's 1991 current ratio dropped to a poor 1.22 from a mediocre 1.54 a year earlier.

MAI Systems Corp. was dead last on the ELECTRONIC BUSINESS 200 liquidity list with a current ratio of 0.41, down from 1.03 in fiscal 1990. MAI Systems is struggling to shift from manufacturing proprietary minicomputers to reselling and integrating industry-standard hardware and software, a battle not made any easier by the recession and the Tustin, Calif., company's huge debt burden. The company's cash reserves shrank from $12.3 million to $9 million in fiscal 1991, and its current liabilities ballooned from $178 million to $300 million.

Despite the lean year, Cabletron Systems Inc., a Rochester, N.H., vendor of data communications equipment, topped the 200 liquidity list with a 9.51 current ratio. Thanks to 72% sales growth to $180.5 million, and a secondary stock offering, Cabletron more than doubled its cash horde to $33 million in fiscal 1991.

Through operations and new public offerings, Conner Peripherals Inc. built up $570 million in cash by the end of fiscal 1991 (ended Dec. 31) and listed total current assets at more than $1.1 billion. The result is a very impressive 6.65 liquidity ratio.

That said, high liquidity can also turn a company into an attractive takeover target. Because most companies in the ELECTRONIC BUSINESS 200 with high current ratios also have high stock prices, they aren't very vulnerable. Conversely, companies with lots of cash and low stock prices—DEC, for instance, with about $1.9 billion in cash reserves—have much to fear from hostile takeover artists. ☐

Where the cash is

Current ratios by industry segment

Distributors	3.90
Communications	3.16
Software	2.75
Consumer	2.65
Desktop	2.64
Peripherals	2.61
Components	2.28
Government	2.23
Semiconductors	2.20
Mainframes	2.18
Minicomputers	2.06
Instruments	1.90

Source: ELECTRONIC BUSINESS

Is the industry growing foreign sales fast enough?

Even though global marketing can reduce a company's risk, only half of the 200 derive a third or more of their revenue from overseas

By Barbara Jorgensen

ELECTRONIC BUSINESS 200 FOREIGN SALES

Datapoint Corp. takes its overseas sales seriously. In 1991, so much of its revenue was derived from Europe that it moved its primary executive headquarters to Paris. Although Datapoint's overall sales fell slightly in 1991, its European sales grew by 10%.

With 94.4% of its total revenue coming from offshore—a higher percentage than any other company in this year's ELECTRONIC BUSINESS 200—San Antonio, Tex.-based Datapoint is anything but typical. The weighted average for the ELECTRONIC BUSINESS 200 was 34.3% in 1991, up from 1990's 33.6%. That reflects a steady climb in foreign sales for the aggregate 200. In 1985, a mere 14% of the EB 200's sales came from offshore.

Sounds as if the electronics marketplace is getting pretty global, right? Nope. Barely half of the EB 200—107 companies, to be exact—derive one-third or more of their sales from foreign markets. Of the remaining 93, 24 either don't sell overseas or sell so little they don't even have to report it.

"I think that if [U.S.] companies hope to survive the next 25 years, they'll *have* to take a global look at the marketplace. Those that do not adapt globally will not survive." That warning comes from Fred Krehbiel, CEO of connector manufacturer Molex Inc., a company that knows a thing or two about foreign sales. Molex's sales split between the U.S./Europe (45%) and Asia (55%) helped the company grow 19% in a world connector market that grew only 4.3% last year. Molex is one of a handful of U.S. companies with more sales to Japan than to the U.S.

IBM generated the most dollars in foreign sales—$40 billion—and ranked #1 in terms of dollar value. But the company ranked #13 in terms of the ratio of foreign sales to total sales—62.3%. At the bottom of the list are many non-manufacturing companies—distributors, for example. That's likely to change by next year's EB 200: U.S. distribution leaders Avnet Inc. and Arrow Inc. announced in 1991 they expanded into Europe, either by investing in or buying European distributors.

Of the five EB 200 companies with the highest percentages of foreign sales, most were able to offset slow U.S. sales in 1991 with growth in foreign markets. CIM developer Measurex Corp. (68.4%), for example (which was not among last year's top five), reported a slowdown in Sweden, the U.K., and Germany, but saw sales improve in the Pacific Rim. "If a company is to be a leader in its niche," says Measurex communications director Carol Wilson, "it must serve all the potential customers it can reach. For Measurex, development of overseas markets is an important form of diversification that reduces risk."

Companies that can't adapt globally won't survive, warns Molex's Fred Krehbiel

Three of the top five in foreign sales—Datapoint, Molex, and Measurex—spread their risks pretty successfully in 1991. Datapoint displaced Tandon Corp. (78.6% this year) as the top foreign seller. Molex's percentage of foreign sales grew from 71.1% in 1990 to 75.8%, and Measurex displaced Micropolis (66.6%), one of last year's top-five companies.

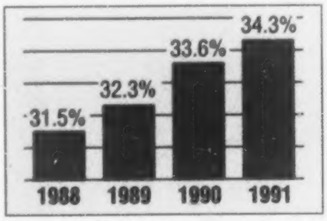
But don't pack for Europe yet: Tandon also derives most of its sales from Europe, and the PC maker's European sales dropped by 11%. Overall sales were up 5%, but Tandon is feeling the effects of desktop, laptop, and notebook pricing pressure, particularly from Asian competition. Datapoint, a networking systems company, is riding the wave of a networking boom in its four main areas: information processing, personal computing, telephone services, and videoconferencing.

Both Measurex and Molex entered foreign markets in the early 1970s, a period during which Krehbiel says it was easier to enter Japan. (As Krehbiel tells it, that was around the same time his father told him he wasn't making enough of a contribution to the company and dispatched him overseas.) In 1970, Measurex determined that two-thirds of its primary end-market, paper and pulp manufacturing, was offshore. Its first two sales were in the U.K. and Finland. The company sold its first system to Japan in 1973.

Measurex and Molex agree on the first tenet of overseas manufacturing, whether it's in Europe or Japan: Establish a local presence in the targeted market and hire nationals to run the business.

Foreign/total sales

(Ratio)



Average for the 200

The top five		200 rank
Datapoint	94.4%	166
Atari	86.1%	165
Tandon	78.6%	102
Molex	75.8%	81
Measurex	68.4%	169
Median for the 200	36.0%	
The five most improved		
Advanced Micro Devices	83.7%	55
Dell Computer	72.7%	70
Microsoft	62.5%	38
Silicon Graphics	59.2%	87
Conner Peripherals	55.3%	45

• % change in foreign sales, fiscal 1990 to 1991; excludes companies that made major acquisitions.

Excludes companies with no foreign sales

Source: ELECTRONIC BUSINESS

Molex's entree into Japan began as a joint venture. Two years later, it was a wholly owned subsidiary managed by Japanese employees. "We wanted to run [Molex Japan] like a Japanese company, and not burden our local managers with our way of doing business," says Krehbiel.

The second piece of advice, says Krehbiel: Don't force-feed your product to the marketplace. Study what your customers need and deliver exactly that. For Molex, that meant developing miniature connectors for Japan's consumer marketplace before that trend reached the United States. When U.S.-made computers and peripherals began to get smaller, Molex had a head start. The company also was able to introduce CIM to its Japanese manufacturing operations and leverage its telecom expertise from its European customers into other markets.

Next, take a long-term view and realize success will not happen overnight. Molex and Measurex have been operating in foreign markets for more than two decades. "Be prepared to invest time and effort," says Krehbiel, "and you're going to have a good shot it. We've had major Japanese corporations doing business with us for 22 years."

The importance of balance can't be overemphasized, although Krehbiel claims Molex didn't start out to capture 54.9% of its sales from the Far East, 27.1% from the Americas, and 17.5% from Europe. Balance, he says, developed along with the connector market. "The U.S. is the biggest market, with Europe and Japan a close second. You should have a good balance as long as it reflects the market. You can't just target 25% of your sales from outside the U.S. if the market won't support it."

Measurex's sales breakdown is similar: 44% from Europe, 31% from the Americas, and 25% from the rest of the world. "When the U.S. paper industry started into its recession about two and a half years ago, our European market was doing well," says Wilson. "Now, when the U.S. is beginning to recover, Europe is having a downturn. These fluctuations balance our performance and help us avoid drastic drops in revenue during hard times."

Last, advises Krehbiel, be prepared to deal with your global customers at their headquarters and design centers, particularly when discussing supply relationships and specialty products. "You have to deal with them locally, where their factories are, on a day-to-day and servicing basis." □

How reliable are those productivity numbers?

The figures reported to the public are so riddled with nuances that companies can make the data mean almost anything

By E. B. Baatz

ELECTRONIC BUSINESS 200 PRODUCTIVITY

For many of the top 200 largest U.S. electronics companies last year, eking out productivity gains was a painful process. Average productivity for the bunch rose a meager 4.7% in fiscal 1991, far from the stellar 12% gain of the year before. The key to last year's productivity gain was a 4.4% drop in employment. More than half of the companies cut their payrolls, which left only 5.5 million people employed by the top 200 in 1991. That's down 23% from 1985, when the top 200 largest electronics companies employed 7.1 million people.

The median productivity figure for the top 200 stood at $137,000 last year; half were higher and half were lower. At the top, with a mind-boggling $1 million-plus in revenue per employee, stands computer and software distributor Merisel Inc. of El Segundo, Calif. On the bottom, with $45,000, is magnetic recording head manufacturer Applied Magnetics Corp. of Goleta, Calif.

It's logical to conjecture that Merisel must be one heck of a company and that Applied Magnetics must be in big trouble. That notion, however, begs the question: What do comparisons of revenue per employee really mean? The answer, say many, is "not necessarily much."

"CFOs in particular get quite skittish showing revenue per employee," says Margaret Epperheimer, vice president of corporate services for The Ask Companies in Mountain View, Calif. "This number is far more complex than one would want it to be."

Exactly how employment and revenue get calculated is one infuriating problem. It's so arbitrary, in fact, the method chosen may vary from year to year even within the same company. For example, some companies report head count at year-end while others report average employment for the entire year. In a growing company, the latter will yield a higher productivity figure.

How revenue gets reported by the bean counters can tangle the productivity equation, too. Suppose a company buys a box for $80,000 and resells it for $100,000. The company may add only the net $20,000 to its top revenue line. Or it may choose to report the entire $100,000 on its top line and deduct $80,000 on its cost line. Either way, the bottom line doesn't change, but productivity will be inflated in the latter case.

Furthermore, productivity comparisons of companies even in similar market segments can be misleading because some contract out labor-intensive business functions while others do not. "We do the whole nine yards: design, develop, manufacture, sell, and service," says Richard Egan, chairman of storage product maker EMC Corp. in Hopkinton, Mass. Comparing EMC to companies that use contract manufacturers and distributors isn't exactly fair. The same goes for Wyle Laboratories Inc. of El Segundo, Calif., a distributor that has a separate defense R&D division. That scientist-laden division drags down Wyle's revenue per employee and skews comparisons against other pure-play distributors.

Even the most productive companies' finance officers caution against placing too much emphasis on revenue per employee.

"I don't get too excited that we're second best [in peripherals]... says William Marriner, senior vice president

"I don't get too excited that we're second best [in the peripherals category]. It depends on the structure of your business, so you can't look at revenue per employee and say you're better or worse," agrees William Marriner, senior vice president of finance and administration for tape drive maker Exabyte Corp. of Boulder, Col.

Two other subtle distinctions make intercompany comparisons tough. One must ask where a company is in its product development stage-and in its acquisition stage. For example, a company that is investing heavily in labor during the early stages of product development looks temporarily bad in a productivity snapshot. Also, a company that makes an acquisition and quickly cuts redundant functions such as accounting and corporate support services will get a sudden jump in productivity. Or if the acquisition is made late in the year and the cuts aren't made before the year-end employee count is reported, the acquisitions may make a company's productivity numbers look temporarily low.

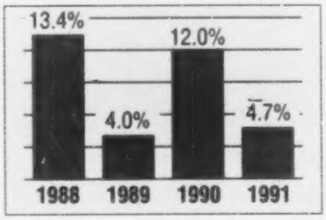
Although cautious about comparisons with others, most finance officers in the electronics industry do rely on the revenue-per-employee figure as an internal measure. "We use it as a head-count management tool and I look at the number very closely every three months," says Exabyte's Marriner. There's plenty of room for cheating, however. "We have a tendency to use the revenue-per-employee number when it's good. When it's not, we don't," says one source.

Many rely on more sophisticated measures of corporate productivity, although these yardsticks aren't readily available to the public. And for executives who answer to the sound of ticker tape on Wall Street, profits per employee are even more important than revenue.

"Revenue per employee is not the final answer. Use the numbers as a guideline or benchmark, but you have to analyze and rationalize them," warns Leonard J. LeBlanc, chief financial officer for Cadence Design Systems Inc. No one said it was going to be easy.

Sales per employee

(Annual % change)



Average for the 200

The top five		200 rank
Merisel	$1,093,400	46
Tech Data	937,600	86
Emerson Radio	929,700	79
Anthem Electronics	694,800	113
Quantum	607,400	60
Median for the 200	$137,000	
The five most improved*		
Storage Technology	25.2%	58
Solectron	21.7	137
Symbol Technologies	20.2	136
Sun Microsystems	20.1	20
Intel	18.4	14

* % change, fiscal 1990 to 1991; includes only companies that increased employment

Source: ELECTRONIC BUSINESS

Here's another way to count those beans

Gilbert F. Amelio, president and chief executive officer for National Semiconductor Corp., offers an alternative measure of corporate productivity.

Q: You don't think much of the revenue-per-employee measure of productivity. What measure do you use at National Semiconductor?

A: I finally decided the only valid way to measure productivity was to look at value added. Specifically, we take sales, subtract purchased materials, and divide by employee payroll.

Q: The value-added concept makes sense, but why do you use payroll data?

A: Using employee payroll instead of head count corrects for different international pay scales. For example, we make diodes in the Philippines. When you factor in that operation, you add a lot of people [because it's more labor intensive] and it doesn't look very productive.

Q: How do the value-added numbers work out?

A: For every $1 we paid in payroll we produced a little more than $2 in value. The range for a typical manufacturing company is 1:2 to 1:3. A ratio of 1:3 is world class, so we could do a little bit better.

Going back to basics pays off for Varian

Net profits at the diversified company rose 356% last year, but CEO Tracy O'Rourke says there's still a long way to go

By Barbara Jorgensen

ELECTRONIC BUSINESS 200
MOST IMPROVED
BIG COMPANY

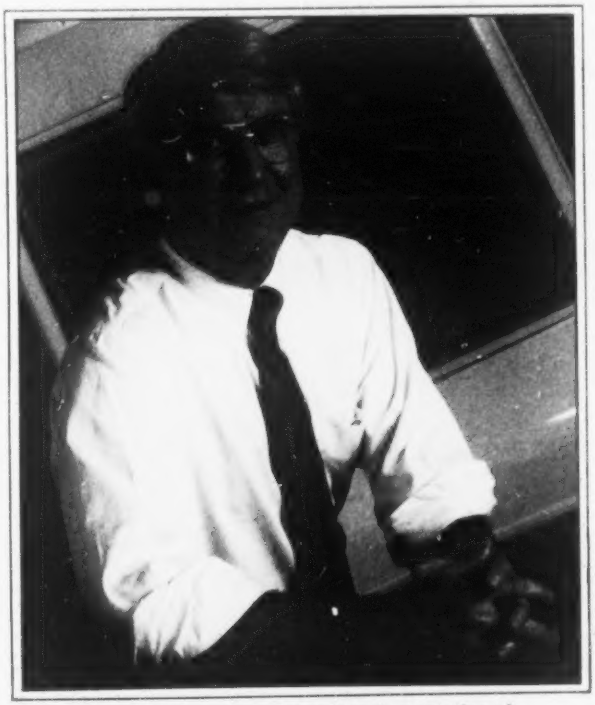
Varian Associates' CEO J. Tracy O'Rourke shrugs off some of his profit-netting restructuring methods as "textbook." **And some of them are.** Divesting **the instrument and equipment maker** of its unprofitable **operations, trimming employee** rosters, and **improving manufacturing** efficiency is pretty much standard operating procedure in cutting costs. Still, O'Rourke and his management team implemented some specific employee and customer programs that helped make Varian, which was ranked #50 on this year's ELECTRONIC BUSINESS 200, also the most-improved large company of the list.

O'Rourke is the first to point out that fiscal 1990 included a $52 million restructuring charge that skews 1991's results a bit. Nonetheless, Varian's net profits rose by 356.4% during fiscal year 1991, ended Sept. 30, to $57.5 million, up from $12.6 million in 1990. Profits were 4.2% on sales of $1.4 billion, up from 1% in 1990. The company's 1991 ROE came in at 13.2%, compared with an average of 5.8% for this year's 200.

Palo Alto-based Varian is about halfway through a three-phase program that O'Rourke hopes will eventually produce a consistent 10% return on sales, which has ranged between 1% and 4% for a number of years.

Although the company has been profitable for eight out of the last 10 years, when O'Rourke replaced retiring chairman and CEO Thomas Sege in February 1990, Varian had been losing its edge because of slow product development and inefficient manufacturing practices. The company had also been force-feeding its latest technology to customers that didn't need it. And Varian had over-diversified, distracting it from its core businesses.

The first phase, completed in fiscal '91, included selling 11 of Varian's divisions or product lines for some $60 million. Of the four remaining businesses—semiconductor production equipment, analytical instruments, electron devices, and medical equipment—all but electron devices saw sales growth last year.



Christopher Springmann

"We often targeted our own elegant implementation of technology," admits Varian CEO Tracy O'Rourke

The second phase is what O'Rourke calls establishing "organizational excellence," a focus on internal improvement through quality, customer satisfaction, faster time-to-market, and flexible factories. Each, either through cost-savings or improved sales, has improved Varian's bottom line.

Achieving faster time-to-market involved a lot of interrelated procedures: culture change, "modern" manufacturing, and employee empowerment. An ingrained culture that fostered a "late is OK" attitude, combined with inefficient manufacturing, had Varian shipping product up to 9 months past the promised date.

Speed and reaction time were put at the top of everybody's list. Quality training was stepped up. Varian management also sought employee suggestions on what customers wanted, and they were empowered to respond. "People always wanted to be told what to do, and if someone wasn't there to do that, nothing would happen," notes O'Rourke. "We had to work on empowering our employees to make decisions."

One such scenario was worked out at Varian's Medical Equipment group. The unit's president, Tim Guertin, and the quality improvement team drew up a model for gauging improvement in process, products, and personnel. "Everyone must know what, when, and how much to do," says Guertin. "Even more crucial, they all must agree." Early results: The unit's average score on its measurement scale rose from 3.2 to 3.6 on a scale of one to five.

At the same time, layers of management were eliminated. "In one of our divisions we had four to five layers of management between the 'hands-on' guy and highest management," says O'Rourke. "We've reduced that to two." That, combined with other company-wide efficiency programs, helped sales per employee for the entire company to go from roughly $124,000 to $148,000.

Within Varian's manufacturing operations, poor planning meant excess, obsolete, or unusable inventory. "We were throwing away two to three times what an efficient company would throw away," O'Rourke says. Excess and obsolete inventory were discarded, saving warehouse space and personnel to maintain, move, and store it. Just-in-time (JIT) delivery and supplier qualification programs ensured the quality of incoming inventory and cut scrap and assembly-line rework.

Varian also moved to outsource operations such as machining and metal fabrication that formerly were done in-house. "Varian was doing about 50% internal sourcing," says O'Rourke. "We're way below that now."

One example of the programs' combined success is the Varian Medical Equipment facility in the U.K. Varian found that JIT, vendor qualification, and waste-elimination increased plant output by 20%. Eliminating non-value-added tasks—outgoing inspection and checking data entry—gained a 15% reduction in factory floor space and 60% in assembly time.

Cost savings don't come painlessly, and Varian's staff reductions hurt morale. Peak employment at Varian, explains O'Rourke, was 12,400; most recently, that was down to 8,400. Some 1,600 employees left with the divested businesses. Some were economy-related reductions, and 1,200 were due to efficiency gains. To keep morale up, says O'Rourke, "We over-communicated to our employees and were very candid. You can't mislead your employees—they know a lot more about what's going on than you think."

Varian at a glance

Fiscal year ended Sept. 30	1991	1990
Sales (millions)	$1,378	$1,265
Net income (millions)	$57.5	$12.6
Net income/ sales	4.2%	1.0%
Cost of goods/sales	64.0%	65.7%
R&D/sales	6.0%	6.1%
Marketing, G&A/sales	19.6%	18.3%
Number of employees	9,300	10,200
Sales per employee	$148,162	$124,004
Net income per employee	$6,183	$1,235
Capital expenditures/sales	4.3%	4.3%
Current ratio	1.70	1.64
Debt/equity ratio	0.16	0.19
Foreign sales/sales	46.2%	41.5%
Six months ended Mar. 31	1992	1991
Sales (millions)	$619	$676
Net income (millions)	$15	$28

Source: Company reports

In addition to communication on staff reduction, O'Rourke and his management team try to illustrate their commitment to organizational excellence. In the past 18 months, they made 34 visits to Varian's 20 sites worldwide. "It's not an audit—it's a visit," stresses O'Rourke. Employees are encouraged to share ideas and talk about efficiencies while management works on building confidence. "They are bombarded with success stories," says O'Rourke. One involved a semiconductor equipment division that shipped half its deliveries late to customer Intei in Aloha, Ore. Varian's customer service rep formed a work-out team and with Intel, kept tabs on order requirements, parts availability, and shipping schedules to help flag potential problems. Within a month, deliveries were 100% on time.

Improving internal operations is one thing; pleasing the customer is another. "In too many cases, our product was off target," says O'Rourke. "We often targeted not what the market needed but our own elegant implementation of technology, which added cost." In one case, a sputtering-system customer complained that replacing the system's protective shields took 24 hours, so a Varian sales rep worked with the customer on a redesign. The shields now can be changed in six hours.

Varian has also tried to remove the mystery from many of its machines. A High Point, N.C., lab uses a Varian gas chromatograph (GC) to monitor toxins in water supplies. With the help of his Varian sales rep, Bill Frazier adapted the GC to not just identify but "fingerprint" the sources of pollutants. "Between [the rep], the state, and me, we came up with some intuitive designs, and within four weeks, we were able to prove [a local business] was part of the toxicity problem," says Frazier.

Another important lesson for Varian, says O'Rourke, was to recognize a shift in the buying influence among Varian customers. Using "won-business" and "lost-business" surveys, the company realized that, while salespeople were trained to work with users, "they couldn't talk the same language as the people who signed the check." The sales force is now working to become more adept at explaining Varian products to nontechnical decision makers.

Varian has accomplished a lot in a year, but O'Rourke stresses the job isn't done yet. The third phase, he says, will establish "respectable and consistent" profitability and accelerate growth. How? "We've been hovering around 4% [profit on sales], and we have a multibusiness enterprise," O'Rourke explains. "So, we look at each business and benchmark it against the best in class. You weigh that and come up with something reasonable. For us, that should be 10% return on sales."

The "most-improved" large and small companies (more and less than $1 billion in revenue) were chosen with a combination of criteria including change in profits, productivity, debt-to-capital ratio, R&D-to-sales ratio, and other financial data between 1990 and 1991.

Register Now for a **FREE** subscription to:

Electronic Engineering Television

the television network for electronic engineers

Via satellite:

Emerging Technologies: Shaping New Markets

August 28, 1992; 1PM - 4PM, ET

Videotapes available Sept. 1st

Program
- **Concurrent Engineering**
- **Digital Signal Processing**
- **Fuzzy Logic**
- **Advanced Linear Design**
- **Design Simulation**

Presented by:
- **AMP, Texas Instruments, Analog Devices, Murata Erie, Motorola, and others**

Commentary by:
- **Frank Burge**
  VP & Group Publisher
  Electronic Business Magazine

Electronic Engineering television provides televised educational programs via satellite and videotape which are distributed free to qualified electronic engineering organizations. **Electronic Engineering television** is a subsidiary of The Computer Channel.

To REGISTER for this program you MUST complete the form below and FAX to 516/921/5676 or call 516/921/5170

☐ Yes, please register my organization for the FREE subscription to this program.

☐ We have a satellite dish; please contact us with information.

☐ We need a videotape; we understand there is a $15 duplication and shipping fee.

Name:____________________
Company:____________________
Address:____________________
Voice:____________________
FAX:____________________

Tough acquisition was worth it for Symbol Technologies

New products and buoyant market helped increase sales 38% and boost net earnings by 201%

By Dwight B. Davis

ELECTRONIC BUSINESS 200
MOST IMPROVED SMALL COMPANY

After several years of strong growth, Symbol Technologies Inc. sputtered in 1990 when sales for the bar-code scanner manufacturer grew just 4.1%, to $231.5 million. The big reason was trouble digesting its late-1988 acquisition of portable-terminal vendor MSI Data, whose products weren't as good or market position as strong as Symbol first believed.

1991 was far better. A product-line re-vamp, continued strength in bar scanners, and solid financial controls helped Symbol push sales up 38%, to $319.4 million. That wasn't even the best news. Net earnings grew 201% in 1991, to a record $22.8 million. Return on assets, return on investment, and return on equity all more than doubled from year to year, and sales per employee rose from $120,823 to $145,172 while Symbol's head count grew from 1,916 people in 1990 to 2,200 by 1991. No other electronics company under $1 billion in sales could match the Bohemia, N.Y., company's overall improvement during yet another recession-plagued year.

The overall bar-code scanning marketplace has traditionally grown at an impressive 20% to 30% per year, says Symbol president Raymond Martino. Symbol rose with that market after pioneering the hand-held laser-scanner sector. Currently, the company holds about 85% to 90% of the hand-held laser sector, estimates Walter J. Winnitzki, an analyst with Brown Brothers Harriman & Co. in New York.

Symbol's scanners were first snapped up by the top-tier, non-food retailers during the 1980s, but by the end of the decade, that market was becoming saturated. Symbol began to refocus its marketing efforts toward midsize retailers and new markets. One move was the acquisition of MSI Data, a leader in the hand-held computer terminal business. Symbol management hoped to marry portable scanning devices with portable data terminals (PDTs).

But instead of giving Symbol easy entry into a new market, the company found itself completely reworking the MSI Data product line. "We didn't realize MSI Data's product line was

Symbol Technologies at a glance

Fiscal year ended Dec. 31	1991	1990
Sales (thousands)	$319,376	$231,496
Net income (thousands)	$22,768	$7,576
Net income/ sales	7.1%	3.3%
Cost of goods/sales	44.2%	43.8%
R&D/sales	8.5%	9.5%
Marketing, G&A/sales	30.6%	35.0%
Number of employees	2,200	1,916
Sales per employee	$145,172	$120,823
Net income per employee	$10,349	$3,954
Capital expenditures/sales	5.4%	6.6%
Current ratio	3.55	3.12
Debt/equity ratio	0.09	0.11
Foreign sales/sales	29.7%	31.7%
Three months ended Mar. 31	1992	1991
Sales (thousands)	$89,043	$70,578
Net income (thousands)	$5,491	$4,115

Source: Company reports

"We didn't realize MSI Data's product line was as weak as it was," says Symbol president Martino

as weak as it was," admits Martino. "We actually lost market share in PDTs during that [1989-90] period."

At the same time Symbol struggled to update MSI Data's products, they had to "re-invent ourselves from being a plug-and-play peripherals company to being a systems company that sold [complete systems] as well as [software] applications," says Martino. Reshaping Symbol and absorbing MSI Data also involved a certain amount of culture shock. "We were 98% hardware, and 80% of the people we hired as part of the acquisition were software personnel."

By late 1990, the gamble started to pay off. Not only did Symbol improve MSI Data's existing products, but also it was the first manufacturer to integrate laser scanners into PDTs. The company also developed a wireless communications option called Spectrum One that permits immediate updating of computer databases from information scanned on the store, warehouse, or factory floor.

Tackling these ambitious projects was possible largely because of Symbol's strong fiscal position, says chief financial officer Thomas Amato. "Although we are aggressive in the marketplace and in product development, we maintain a very conservative financial strategy," he adds. "In 1990, we had virtually no debt and a good cash position, so nobody told us to slow down our product development work."

New products began to boost the bottom line in a big way in late 1991 and early 1992:

- The U.S. Postal Service ordered 10,000 integrated scanning terminals from a Symbol systems integrator, Systemhouse Inc. in Arlington, Va.
- K mart Corp. standardized on Spectrum One in its more than 2,000 stores. By June of this year, Symbol had installed wireless systems at more than 1,000 K mart sites.
- JC Penny ordered 38,000 hand-held scanners for use at its point-of-sale locations.
- United Parcel Service will outfit each of its 60,000 drivers with a Symbol hand-held scanner.

A strong patent portfolio has further buttressed Symbol's success. Following recent court battles over patents, virtually all of its competitors have signed licensing agreements with the company.

Early this year, Symbol lost a hotly contested bid to competitor Telxon to supply Wal-Mart with integrated terminals and a wireless communications network. But, notes analyst Winnitzki, Telxon will pay Symbol a 7.5% royalty payment for all the integrated scanning terminals it sells. "Because of [Telxon's] aggressive pricing, Symbol should earn almost as much through royalty payments from Telxon as it would had it won the award outright," he says.

Symbol's strategy has always been to license its patents rather than hoard them for its own use. "We aren't large enough to spread the laser-scanning technology on our own. We license our patents to strong companies that we think will help expand the market," Martino says. "We think we're good enough to win our share of business against our licensees."

Increasingly, that business is overseas. European sales accounted for about 30% of Symbol's 1991 revenue, a market with great growth potential, according to Amato. Japan and other Asian countries have already invested heavily in bar-code systems based on charge coupled device (CCD), not laser, technology. It's unclear if Symbol can penetrate that market, but it has established a joint marketing and manufacturing venture with Olympus Optical Co. in Japan to attack applications in which laser scanners out-perform the CCD competition. Symbol will get a 10% royalty on any systems the Japan plant manufactures and sells. ☐

The "most-improved" large and small companies (more and less than $1 billion in revenue) were chosen with a combination of criteria including change in profits, productivity, debt-to-capital ratio, R&D-to-sales ratio, and other financial data between 1990 and 1991.

How Symbol's sales will change

($ millions)

	1990	1991	1992	1993
Laser scanners and modules	$136.5	$186.0	$214.5	$252.0
Portable terminals and systems	$71.0	$105.0	$143.0	$171.0
Service and other	$24.0	$28.4	$32.5	$37.0
Total	$231.5	$319.4	$390.0	$460.0
Sales growth (% change)	4.1%	38.0%	22.1%	17.9%

Note: Portable terminals and systems includes sales of laser modules in integrated terminals systems.

Source: Brown Brothers Harriman & Co.

Rank 1991	Rank 1990	Company Location	Calendar year 1991: Electronics sales ($ millions)	Total sales ($ millions)	Net profits ($ millions)	Profits as a percentage of sales	Fiscal year 1991: Return on assets	Return on equity	Return on investment
1	1	**IBM** Armonk,N.Y.	$64,792	$64,792.0	$-564.0	-0.9%	-0.6%	-1.5%	-0.9%
2	2	**AT&T** New York,N.Y.	22900	63089.0	522.0	0.8	1.0	3.2	1.6
3	4	**Hewlett-Packard** Palo Alto,Calif.	14949	14949.0	856.0	5.7	6.3	10.4	8.7
4	5	**Digital Equipment** Maynard,Mass.	14238	14238.0	-864.0	-6.1	-5.2	-8.1	-7.9
5	3	**Xerox*** Stamford,Conn.	13819	13819.0	436.0	3.2	5.7	NA	NA
6	6	**GM Hughes Electronics** Detroit,Mich.	11541	11540.6	381.1	3.3	2.9	4.6	4.2
7	7	**Motorola** Schaumburg,Ill.	11341	11341.0	454.0	4.0	4.8	9.8	7.1
8	9	**General Electric** Fairfield,Conn.	9530	60236.0	4435.0	7.4	2.6	20.5	4.6
9	8	**Unisys** Blue Bell,Pa.	8696	8696.1	-1393.3	-16.0	-16.5	-69.2	-26.3
10	10	**Texas Instruments** Dallas,Tex.	6784	6784.0	-409.0	-6.0	-8.2	-20.9	-14.2
11	13	**Apple Computer** Cupertino,Calif.	6496	6496.0	325.4	5.0	8.9	17.5	16.2
12	11	**Honeywell** Minneapolis,Minn.	6193	6192.9	331.1	5.3	6.9	18.0	12.5
13	14	**Raytheon** Lexington,Mass.	5501	9274.2	591.8	6.4	8.1	14.8	11.0
14	18	**Intel** Santa Clara,Calif.	4779	4778.6	818.6	17.1	13.0	18.5	16.5
15	15	**Rockwell International** El Segundo,Calif.	4524	11549.5	582.3	5.0	6.3	14.2	11.5
16	16	**Tandy** Ft. Worth,Tex.	4515	4514.7	176.2	3.9	6.7	11.2	8.4
17	17	**Eastman Kodak** Rochester,N.Y.	3968	19419.0	17.0	0.1	0.1	0.3	0.1
18	19	**Lockheed** Calabasas,Calif.	3830	9809.0	308.0	3.1	4.7	12.3	7.4
19	21	**3M** St. Paul,Minn.	3500	13340.0	1154.0	8.7	10.4	18.3	14.9
20	30	**Sun Microsystems** Mountain View,Calif.	3455	3454.7	199.3	5.8	8.2	15.7	11.6
21	31	**Seagate Technology** Scotts Valley,Calif.	3372	3372.1	73.9	2.2	3.3	8.2	5.3
22	20	**Compaq Computer** Houston,Tex.	3271	3271.4	130.9	4.0	4.6	6.8	6.5
23	23	**Westinghouse Electric** Pittsburgh,Pa.	3245	12794.0	-1086.0	-8.5	-5.4	-29.0	-14.3
24	24	**Litton Industries** Beverly Hills,Calif.	3076	5463.5	68.4	1.3	1.3	5.5	4.4
25	26	**Martin Marietta** Bethesda,Md.	3025	6075.4	313.1	5.2	8.0	17.4	12.7
26	25	**Harris** Melbourne,Fla.	3017	3017.1	89.7	3.0	0.8	1.9	1.1
27	42	**Loral** New York,N.Y.	2870	2870.1	112.1	3.9	3.6	13.4	6.1
28	27	**TRW** Cleveland,Ohio	2800	7913.0	-140.0	-1.8	-2.5	-8.3	-4.2
29	29	**Allied-Signal** Morristown,N.J.	2775	11831.0	-273.0	-2.3	-2.6	-9.2	-4.7
30	34	**GTE** Stamford,Conn.	2643	19621.0	1529.0	7.8	3.6	13.5	5.2
31	33	**AMP** Harrisburg,Pa.	2631	3095.0	259.7	8.4	8.6	13.6	11.3
32	28	**ITT** New York,N.Y.	2525	20421.0	817.0	4.0	1.5	8.9	4.2
33	22	**Ford Motor** Dearborn,Mich.	2510	92055.4	-2258.0	-2.5	-1.3	-10.0	-7.1
34	35	**DuPont** Wilmington,Del.	2500	38695.0	1403.0	3.6	3.9	8.4	5.6
35	32	**Boeing** Seattle,Wash.	2470	29314.0	1567.0	5.3	9.9	19.4	16.7
36	36	**Emerson Electric** St. Louis,Mo.	2434	7443.4	637.7	8.6	9.9	19.4	14.1
37	38	**Pitney Bowes** Stamford,Conn.	2353	3332.5	287.9	8.6	4.5	16.0	6.0
38	47	**Microsoft** Redmond,Wash.	2276	2275.9	584.4	25.7	28.1	34.3	34.3
39	45	**E-Systems** Dallas,Tex.	1991	1991.3	109.5	5.5	10.2	14.6	13.0
40	37	**Wang Laboratories** Lowell,Mass.	1944	1944.0	-373.4	-19.2	-26.7	-717.1	-65.1
41	41	**Tandem Computers** Cupertino,Calif.	1933	1932.9	-52.4	-2.7	1.8	2.8	2.5
42	40	**McDonnell Douglas** St. Louis,Mo.	1790	18448.0	355.0	1.9	2.4	9.2	4.4
43	39	**Amdahl** Sunnyvale,Calif.	1702	1702.5	4.4	0.3	0.2	0.3	0.3
44	43	**National Semiconductor** Santa Clara,Calif.	1656	1655.9	-150.4	-9.1	-12.6	-22.8	-21.3
45	51	**Conner Peripherals** San Jose,Calif.	1599	1599.0	92.5	5.8	6.9	13.0	8.4
46		**Merisel** El Segundo,Calif.	1585	1585.4	10.8	0.7	2.5	9.5	9.2
47	50	**Johnson Controls** Milwaukee,Wis.	1522	4626.1	98.9	2.1	3.3	8.9	5.3
48	46	**Avnet** Great Neck,N.Y.	1508	1694.2	51.2	3.0	5.2	7.7	6.1
49	52	**Computer Associates** Garden City,N.Y.	1438	1437.8	173.0	12.0	10.0	14.6	14.2
50	53	**Varian Associates** Palo Alto,Calif.	1366	1366.0	52.7	3.9	6.5	13.2	11.2

NA = not available
NM = not meaningful

*Data processing operations only

**See "Notes to the ELECTRONIC BUSINESS 200"

Cost of goods as a percentage of sales	SG&A as a percentage of sales	Sales per employee ($ thousands)	Profits per employee ($ thousands)	Five-year growth (Compounded average annual growth rate)		Current ratio	Debt to capital	Foreign sales as a percentage of total sales	Fiscal year ended	Industry segment code**
				Sales	Profits					
39.7%	38.2%	$188.1	$-1.6	4.4%	NM	1.22	42.1	62.3%	12/91	7.10
46.4	25.7	199.0	1.6	0.4	1.9	1.17	48.9	8.6	12/91	--
49.9	27.3	162.9	8.5	15.3	7.9	1.65	16.0	55.9	10/91	1.7
46.4	32.1	115.0	-5.1	12.9	NM	1.87	2.2	60.4	6/91	12
48.2	32.5	137.0	4.3	NA	NA	NA	NA	51.0	12/91	13
73.1	10.8	124.1	4.1	2.0	14.9	1.47	9.4	0.0	12/91	8
46.6	21.8	111.2	4.5	13.9	18.5	1.46	28.1	55.9	12/91	2,15
49.4	9.3	212.1	15.6	10.4	12.2	NA	77.3	26.6	12/91	--
62.3	29.0	144.2	-23.1	3.2	NM	1.17	62.0	51.0	12/91	10
74.8	18.8	107.8	-6.5	6.3	NM	1.52	32.1	35.1	12/91	8,15
49.3	27.6	437.1	21.5	27.1	15	2.35	7.8	44.8	9/91	5
66.3	18.6	106.4	5.7	6.7	NM	1.29	30.4	33.8	12/91	7.9
76.0	8.9	129.5	6.9	4.9	4.6	1.38	25.6	17.7	12/91	8
39.7	16.0	194.3	33.3	30.4	NM	2.94	10.8	51.3	12/91	15
75.0	11.6	137.1	6.9	-0.6	-0.3	1.45	19.4	25.7	9/91	--
53.0	35.4	114.0	5.2	8.5	0.8	3.18	24.8	7.8	6/91	4
43.8	28.7	145.8	0.1	11.0	-46.1	1.2	62.6	44.0	12/91	--
86.1	0.7	135.7	4.3	-0.3	-6.1	1.23	39.8	13.0	12/91	--
53.1	24.9	150.8	13.0	8.1	8.2	1.73	19.0	48.5	12/91	--
47.7	25.2	257.7	15.2	72.6	86.2	2.53	25.9	51.4	6/91	5
75.7	8.1	62.3	1.5	42.2	12.7	2.0	35.9	36.4	6/91	14
57.7	22.1	327.1	13.1	39.2	25.0	2.79	3.7	57.6	12/91	5
71.5	18.1	100.9	-9.6	0.2	NM	0.77	50.6	24.5	12/91	--
73.2	11.1	99.8	1.2	2.9	-13.4	1.73	19.8	25.8	7/91	8
77.1	7.3	101.4	5.2	5.0	11.1	1.71	27.1	0.0	12/91	8
61.4	23.3	99.0	0.6	9.8	-23.2	1.75	40.1	30.2	6/91	7,8
61.1	19.1	89.5	3.8	26.2	11.3	1.64	55.0	20.7	3/91	8
73.8	10.6	111.0	-2.0	5.6	NM	1.14	49.5	31.6	12/91	--
79.5	11.5	120.4	-2.8	3.7	NM	1.15	48.3	39.3	12/91	-
59.1	0.0	180.0	14.0	67.0	5.2	1.05	61.8	0.0	12/91	--
58.6	18.0	123.8	10.4	9.9	9.6	1.82	16.9	60.5	12/91	3
NA	4.8	185.6	7.4	66.0	9.8	NA	52.9	30.9	12/91	--
93.8	5.5	216.6	-6.8	2.8	NM	1.0	28.7	43.6	12/91	--
51.4	9.2	290.9	10.5	7.6	-1.8	1.45	33.1	46.4	12/91	--
81.3	4.4	188.3	10.1	12.3	18.7	1.41	14.0	60.9	12/91	--
61.2	19.3	106.9	9.1	7.2	8.1	1.43	27.2	34.8	9/91	--
28.2	40.1	113.3	9.8	10.9	13.0	0.65	62.6	22.5	12/91	13
15.5	32.3	224.1	56.3	56.3	63.8	3.51	0.0	57.3	6/91	16
82.6	6.8	106.9	5.9	11.9	12.2	3.51	10.8	8.8	12/91	8
46.6	37.5	124.6	-22.5	-4.4	NM	1.13	90.9	55.8	6/91	12
31.0	43.6	172.1	3.1	19.8	-11.4	1.71	10.2	55.6	9/91	12
82.5	6.2	169.1	3.3	8.8	1.5	NA	52.5	33.4	12/91	--
53.5	21.1	181.1	0.5	12.0	-35.4	2.44	13.9	40.9	12/91	10
65.4	14.2	57.1	-5.0	14.5	NM	1.47	6.5	51.3	5/91	15
77.1	6.5	195.0	11.3	NA	NA	6.65	35.2	63.6	12/91	14
89.9	7.5	1093.4	7.5	NA	NA	2.36	2.6	4.6	12/91	6
80.2	10.4	106.8	2.2	13.1	2.0	1.25	40.8	19.6	9/91	--
74.3	19.3	240.1	8.5	4.2	20.9	5.8	20.2	0.0	6/91	6
NA	54.3	201.2	23.8	21.5	27.4	2.46	2.5	53.2	3/91	16
64.0	19.6	148.2	6.2	11.7	NM	1.7	15.1	46.2	9/91	7,9

(Continued)

Rank 1991	Rank 1990	Company Location	Calendar year 1991 Electronics sales ($ millions)	Total sales ($ millions)	Net profits ($ millions)	Profits as a percentage of sales	Fiscal year 1991 Return on assets	Return on equity	Return on investment
51	54	**United Technologies** Hartford,Conn.	$1,340	$20,840.0	$-1,021.0	-4.9%	-6.4%	-25.8%	-13.9%
52	48	**Zenith Electronics** Glenview,Ill.	1322	1321.6	-51.6	-3.9	-7.5	-16.7	-11.3
53	49	**Tektronix** Beaverton,Ore.	1311	1310.9	44.9	3.4	5.4	11.3	8.4
54	44	**Control Data** Minneapolis,Minn.	1288	1524.9	-8.6	-0.6	-0.7	-1.9	-1.3
55	61	**Advanced Micro Devices** Sunnyvale,Calif.	1227	1226.6	145.3	11.8	11.2	18.5	14.6
56	56	**Data General** Westboro,Mass.	1212	1212.0	77.2	6.4	9.1	17.3	12.9
57	63	**Intergraph** Huntsville,Ala.	1195	1195.4	71.1	5.9	7.1	9.4	9.1
58	58	**Storage Technology** Louisville,Colo.	1175	1174.8	93.1	7.9	5.5	10.5	6.7
59	62	**Oracle Systems** Redwood Shores,Calif.	1085	1085.2	65.0	6.0	-1.4	-3.6	-2.3
60	77	**Quantum** Milpitas,Calif.	1074	1073.6	49.6	4.6	15.1	31.0	31.0
61	64	**Grumman** Bethpage,N.Y.	1055	4037.9	99.3	2.5	4.2	10.1	5.8
62	65	**Arrow Electronics** Melville,N.Y.	1044	1043.7	8.7	0.8	1.2	3.8	1.6
63	55	**Chrysler** Highland Park,Mich.	1030	29370.0	-795.0	-2.7	-1.2	-8.8	-2.1
64	57	**SCI Systems** Huntsville,Ala.	997	996.7	-1.4	-0.1	0.6	1.9	0.8
65	59	**General Dynamics** Falls Church,Va.	985	8751.0	374.0	4.3	6.0	18.9	13.1
66	73	**Maxtor** San Jose,Calif.	961	961.0	-65.8	-6.8	-10	-32.5	-15.2
67	60	**Western Digital** Irvine,Calif.	916	915.9	-95.7	-10.4	-21.6	-72.5	-30.9
68	74	**Corning** Corning,N.Y.	902	3259.2	311.2	9.5	8.1	15.4	11.1
69	67	**Eaton** Cleveland,Ohio	900	3381.0	62.0	1.8	2.0	5.4	3.0
70	87	**Dell Computer** Austin,Tex.	890	889.9	50.9	5.7	9.1	18.6	16.1
71	70	**Medtronic** Minneapolis,Minn.	875	1124.5	154.3	13.7	13.0	19.5	17.1
72	71	**Cray Research** Eagan,Minn.	862	862.5	113.0	13.1	10.5	14.9	13.0
73	68	**Northrop** Los Angeles,Calif.	861	5694.2	268.2	4.7	8.6	22.7	15.5
74	66	**Teledyne** Los Angeles,Calif.	860	3206.8	-25.4	-0.8	-1.5	-5.6	-2.7
75	69	**Beckman Instruments** Fullerton,Calif.	858	857.9	38.1	4.4	5.3	11.1	8.8
76	79	**Lotus Development** Cambridge,Mass.	829	828.9	43.1	5.2	5.9	12.9	8.7
77	82	**AST Research** Irvine,Calif.	827	827.3	70.2	8.5	13.3	22.9	20.6
78	75	**EG&G** Wellesley,Mass.	825	2688.5	81.2	3.0	11.6	19.3	15.8
79	76	**Emerson Radio** North Bergen,N.J.	790	790.2	-60.7	-7.7	-26.9	-1335.1	-29.7
80	72	**General Signal** Stamford,Conn.	750	1615.8	64.0	4.0	5.4	13.4	8.2
81	81	**Molex** Lisle,Ill.	740	739.8	63.3	8.5	9.1	12.8	12.5
82	78	**Perkin-Elmer** Norwalk,Conn.	730	873.5	0.1	0.0	-0.3	-1.0	-0.6
83	88	**Novell** Provo,Utah	710	710.4	184.2	25.9	22.4	27.1	27.0
84	80	**LSI Logic** Milpitas,Calif.	698	697.8	8.3	1.2	1.1	2.8	1.7
85	84	**Applied Materials** Santa Clara,Calif.	661	661.0	28.4	4.3	4.0	8.1	5.4
86		**Tech Data** Clearwater,Fla.	647	647.0	11.9	1.8	5.9	12.6	8.4
87	96	**Silicon Graphics** Mountain View,Calif.	638	637.9	36.6	5.7	5.1	6.6	6.3
88	89	**Eli Lilly** Indianapolis,Ind.	620	5725.7	1314.7	23.0	15.8	26.5	21.7
89	110	**Mark IV Industries** Amherst,N.Y.	581	1123.3	29.5	2.6	2.3	14.0	2.7
90	85	**Marshall Industries** El Monte,Calif.	563	563.0	16.2	2.9	6.8	10.9	8.3
91	86	**Raychem** Menlo Park,Calif.	560	1249.5	-23.4	-1.9	-1.9	-3.6	-2.6
92	91	**Analog Devices** Norwood,Mass.	536	536.0	3.5	0.7	1.6	2.3	2.1
93	98	**Teradyne** Boston,Mass.	509	508.9	18.3	3.6	4.3	6.0	5.4
94	94	**Westmark International** Seattle,Wash.	505	504.7	21.4	4.2	4.7	6.8	6.4
95	83	**Scientific Atlanta** Atlanta,Ga.	503	502.8	-3.3	-0.7	0.3	0.4	0.4
96	104	**Everex Systems** Fremont,Calif.	492	492.5	-31.3	-6.4	-20.3	-52.1	-35.8
97	106	**Dover** New York,N.Y.	492	2195.8	128.2	5.8	9.5	15.5	13.2
98		**Amphenol** Wallingford,Conn.	489	489.1	-6.5	-1.3	-0.9	-2.8	-1.1
99	95	**Dynatech** Burlington,Mass.	477	477.4	12.5	2.6	5.3	10.4	6.7
100		**Fisher Scientific** Hampton,N.H.	470	757.7	7.7	1.0	1.8	7.3	5.8

NA = not available
NM = not meaningful

**See 'Notes to the ELECTRONIC BUSINESS 200'

Cost of goods as a percentage of sales	SG&A as a percentage of sales	Sales per employee ($ thousands)	Profits per employee ($ thousands)	Five-year growth (Compounded average annual growth rate)		Current ratio	Debt to capital	Foreign sales as a percentage of total sales	Fiscal year ended	Industry segment code**
				Sales	Profits					
75.1%	14.5%	$112.6	$-5.5	5.9%	NM	1.36	46.1	55.7%	12/91	--
88.6	7.7	47.7	-1.9	-1.4	NM	2.11	32.6	4.8	12/91	4
43.9	30.7	111.4	4.0	-0.3	4.4	1.49	25.5	49.7	5/91	9
59.7	24.9	117.3	-0.7	-14.5	NM	1.69	31.0	35.1	12/91	7,10
41.0	20.0	109.0	12.9	8.2	NM	1.38	21.2	56.6	12/91	15
45.1	31.3	144.6	10.1	-0.6	71.9	2.43	25.7	52.0	9/91	12
45.0	29.9	116.1	6.9	11.4	0.2	3.42	3.5	46.4	12/91	5
61.2	18.6	156.9	9.2	17.9	53.6	1.97	36.1	39.2	12/91	14
72.7	9.8	137.7	-1.7	79.3	NM	1.22	36.5	61.6	5/91	16
74.0	7.4	607.4	51.1	48.6	27.2	1.6	0.0	44.7	3/91	14
88.8	3.1	171.1	4.2	2.9	4.8	3.88	42.3	8.3	12/91	--
77.9	16.7	248.5	2.1	15.8	NM	2.76	59.1	0.0	12/91	6
85.5	11.4	206.3	-4.3	3.1	NM	NA	76.1	18.9	12/91	--
88.7	1.8	115.6	0.4	19.1	-24.2	2.98	56.0	43.5	6/91	--
82.6	7.6	108.6	4.6	-0.5	98.9	1.39	30.8	15.7	12/91	--
82.8	9.7	104.9	-5.5	56.4	NM	1.77	53.2	26.8	3/91	14
78.0	11.8	146.3	-19.9	26.8	NM	1.9	57.3	60.3	6/91	14
58.0	19.1	106.2	10.1	10.9	11.3	1.74	28.0	27.4	12/91	--
72.1	14.0	94.8	1.7	4.3	-14.8	1.7	44.6	31.2	12/91	--
66.7	20.3	296.6	17.0	66.5	88.1	2.23	13.1	36.4	1/92	5
27.9	38.6	135.1	17.6	19.9	14.4	2.1	12.6	42.1	4/91	11
22.7	18.4	159.9	21.0	7.6	-2.0	2.7	13.0	55.1	12/91	10
79.7	9.3	157.3	7.4	0.3	45.6	1.51	31.7	0.0	12/91	--
77.6	15.9	109.1	-0.9	-0.2	NM	1.79	52.3	16.7	12/91	--
42.2	33.0	124.3	5.5	7.7	12.4	1.86	20.7	55.6	12/91	11
12.5	53.2	192.8	10.0	24.0	-2.2	1.76	32.9	50.8	12/91	16
62.3	18.5	232.6	21.9	31.9	18.9	2.99	10.2	40.1	6/91	5
85.8	8.3	75.5	2.3	17.7	11.1	1.89	18.1	7.6	12/91	--
94.0	5.3	929.7	-71.5	7.0	NM	0.86	97.8	0.0	12/91	4
68.8	20.6	109.6	4.3	2.9	-1.0	1.68	38.9	29.8	12/91	--
49.6	26.2	101.8	9.3	19.4	15.1	2.75	2.0	75.8	6/91	3
47.7	32.8	137.6	-0.4	10.7	NM	1.24	36.9	64.3	7/91	9
15.5	33.2	225.1	57.2	39.8	62.6	4.68	0.4	43.8	10/91	16
54.5	19.6	166.0	2.0	29.1	11.4	2.4	40.0	47.5	12/91	15
54.1	17.7	180.2	7.4	33.7	69.8	2.17	33.1	66.1	10/91	--
89.2	6.8	937.6	17.2	NA	NA	1.82	33.0	0.0	1/92	6
40.4	34.2	220.0	13.2	67.7	76.9	4.13	5.8	52.8	6/91	5
23.7	26.8	185.9	42.7	14.3	18.7	1.29	17.9	36.7	12/91	--
60.4	20.6	82.2	2.2	61.6	39.4	3.22	80.4	20.1	2/91	7
76.0	17.1	364.2	10.8	18.9	43.3	4.09	24.2	0.0	5/91	6
45.1	35.8	109.5	-2.1	9.4	NM	2.55	28.9	66.7	6/91	--
40.9	28.3	103.4	1.6	10.0	-18.9	2.57	10.7	53.8	10/91	15
51.0	24.8	118.4	4.2	7.7	NM	2.51	9.4	47.0	12/91	9
49.2	30.4	136.0	5.8	15.7	NM	2.93	7.1	31.0	12/91	11
68.1	19.7	164.6	0.4	1.0	NM	3.58	0.9	22.0	6/91	2
77.1	17.0	186.0	-21.0	46.4	NM	1.37	31.4	17.4	7/91	5,14
68.1	20.6	116.2	6.8	8.8	8.9	1.59	14.6	35.9	12/91	--
60.7	16.2	86.6	-1.2	1.8	NM	2.57	60.9	41.7	12/91	3
42.8	34.7	152.8	4.9	11.3	-6.3	2.88	35.2	30.4	3/91	2
67.1	25.7	236.8	2.4	5.2	NA	1.78	20.3	0.0	12/91	11

(Continued)

Rank			Calendar year 1991				Fiscal year 1991		
1991	1990	Company Location	Electronics sales ($ millions)	Total sales ($ millions)	Net profits ($ millions)	Profits as a percentage of sales	Return on assets	Return on equity	Return on investment
101	90	**DSC Communications** Plano,Tex.	$461	$461.5	$-108.3	-23.5%	-18.1%	-62.0%	-23.7%
102	107	**Tandon** Moorpark,Calif.	461	461.4	-48.0	-10.4	-19.9	-98.7	-45.8
103	120	**Micron Technology** Boise,Idaho	457	456.9	15.0	3.3	0.7	1.0	0.9
104	103	**Diebold** Canton,Ohio	456	506.2	35.7	7.1	6.7	9.0	8.9
105	92	**Reliance Electric** Cleveland,Ohio	455	1516.0	34.0	2.2	2.9	50.7	5.2
106	97	**Monsanto** St. Louis,Mo.	450	8864.0	296.0	3.3	3.2	8.1	5.0
107	113	**Stratus Computer** Marlborough,Mass.	449	448.6	49.7	11.1	12.9	15.8	15.4
108	100	**Vishay Intertechnology** Malvern,Pa.	442	442.3	20.9	4.7	4.7	10.4	5.9
109	112	**Applied Magnetics** Goleta,Calif.	440	440.3	-20.5	-4.7	-6.1	-12.2	-8.2
110	199	**Borland International** Scotts Valley,Calif.	437	436.5	-75.1	-17.2	19.8	31.6	28.1
111	93	**Penn Central** Cincinnati,Ohio	435	1669.4	63.4	3.8	1.9	4.3	2.9
112	114	**Polaroid** Cambridge,Mass.	435	2070.6	683.7	33.0	36.2	88.5	48.2
113	111	**Anthem Electronics** San Jose,Calif.	420	419.6	23.3	5.6	12.8	15.6	15.6
114	108	**Premier Industrial** Cleveland,Ohio	419	631.7	73.1	11.6	21.4	25.6	25.0
115	118	**Andrew** Orland Park,Ill.	419	418.5	22.4	5.3	6.5	10.2	7.9
116	124	**VLSI Technology** San Jose,Calif.	413	413.4	9.9	2.4	2.7	6.1	3.4
117		**Black & Decker** Towsen,Md	410	4637.0	53.0	1.1	1.0	5.2	1.4
118	102	**Mentor Graphics** Wilsonville,Ore.	400	400.1	-61.6	-15.4	-13.8	-23	-19.1
119	162	**Ask Computer Systems** Mountain View	396	395.5	-56.3	-14.2	0.7	1.5	1.2
120	176	**Cadence Design Systems** San Jose,Calif.	392	392.3	-21.7	-5.5	-6.2	-11.5	-10.1
121	115	**M/A-Com** Wakefield,Mass.	379	378.8	17.1	4.5	4.8	14.6	8.5
122	105	**ESCO Electronics** St. Louis,Mo.	370	453.1	-67.3	-14.9	-12.3	-17.3	-16.5
123	101	**3Com** Santa Clara,Calif.	370	369.6	-32.8	-8.9	-10.2	-14.5	-14.5
124	121	**Pioneer-Standard** Cleveland,Ohio	360	360.3	6.3	1.7	5.7	15.7	8.5
125	119	**Wyle Laboratories** El Segundo,Calif.	360	453.4	9.7	2.1	2.2	4.0	2.9
126	123	**Smith Corona** New Canaan,Conn.	357	357.0	17.2	4.8	10.7	24.3	17.2
127	128	**Sequa** New York,N.Y.	355	1878.8	15.0	0.8	0.7	2.2	1.0
128	117	**Micropolis** Chatsworth,Calif.	351	350.9	4.3	1.2	1.8	3.8	2.2
129	178	**Becton Dickinson** Franklin Lakes,N.J.	351	2190.9	182.1	8.3	6.8	13.9	8.5
130	122	**Archive** Costa Mesa,Calif.	345	344.9	-49.3	-14.3	-18.9	-94.4	-26.7
131	160	**Thermo Electron** Waltham,Mass.	342	805.5	47.1	5.8	3.9	9.8	6.4
132	138	**Acuson** Mountain View,Calif.	336	336.3	58.5	17.4	23.5	29.3	29.3
133	132	**LTV** Dallas,Tex.	330	5986.4	74.1	1.2	1.1	NM	NM
134	141	**Audiovox** Hauppauge,N.Y.	328	328.0	-14.7	-4.5	-10.7	-31.4	-13.7
135	131	**Imo Industries** Lawrenceville,N.J.	320	1024.0	11.4	1.1	1.1	3.4	1.4
136	175	**Symbol Technologies** Bohemia,N.Y.	319	319.4	22.8	7.1	6.4	8.7	7.9
137	184	**Solectron** San Jose,Calif.	317	317.3	11.2	3.5	6.8	19.6	14.0
138	125	**Cubic** San Diego,Calif.	317	317.1	11.1	3.5	5.2	9.3	7.0
139	130	**Savin** Stamford,Conn.	312	312.3	-97.4	-31.2	-97.4	NM	NM
140	127	**Inmac** Santa Clara,Calif.	298	298.1	3.8	1.3	6.3	14.9	9.9
141	172	**Teradata** El Segundo,Calif.	297	297.0	9.1	3.1	-0.9	-1.5	-1.2
142	126	**Sprague Technologies** Stamford,Conn.	294	294.1	-52.5	-17.9	-30.9	-48.4	-38.5
143	137	**QMS** Mobile,Ala.	294	293.6	14.5	4.9	10.6	18.5	14.9
144	136	**Sundstrand** Rockford,Ill.	290	1669.2	108.8	6.5	6.3	15.7	9.5
145	159	**Pittway** Northbrook,Ill.	290	981.6	25.5	2.6	3.4	6.4	4.9
146	180	**Cypress Semiconductor** San Jose,Calif.	287	286.8	34.2	11.9	9.1	11.4	11.2
147	155	**Logicon** Torrance,Calif.	287	286.7	12.3	4.3	8.7	12.4	12.4
148	145	**ADC Telecommunications** Minneapolis	286	285.7	14.0	4.9	8.9	13.9	10.8
149	171	**Autodesk** Sausalito,Calif.	285	284.9	57.8	20.3	17.6	21.6	21.6
150	149	**Diasonics** Milpitas,Calif.	285	284.6	18.9	6.6	6.9	11.3	9.7

NA = not available
NM = not meaningful

**See 'Notes to the ELECTRONIC BUSINESS 200'

Cost of goods as a percentage of sales	SG&A as a percentage of sales	Sales per employee ($ thousands)	Profits per employee ($ thousands)	Five-year growth (Compounded average annual growth rate)		Current ratio	Debt to capital	Foreign sales as a percentage of total sales	Fiscal year ended	Industry segment code**
				Sales	Profits					
58.4%	19.2%	$141.5	$-33.2	18.8%	NM	1.02	61.7	10.4%	12/91	2
77.6	28.0	278.6	-29.0	35.8	NM	1.24	53.6	78.6	12/91	5
57.0	10.6	103.9	1.2	54.1	NM	2.17	15.9	26.0	8/91	15
62.7	19.1	131.2	9.3	3.9	0.5	2.78	0.8	21.9	12/91	1
69.3	16.5	107.4	2.4	5.4	6.3	2.54	89.8	13.8	12/91	--
49.3	20.0	225.7	7.5	5.2	-7.3	1.71	37.7	36.4	12/91	--
31.5	30.2	180	19.9	29.2	29.8	4.77	2.4	47.4	12/91	12
65.8	17.2	50.8	2.4	49.8	16.1	2.65	43.1	51.9	12/91	3
75.1	8.9	45.5	-1.8	28.9	NM	1.17	33.0	56.2	9/91	3
17.8	52.4	230	27.2	50.2	97.2	2.09	11.0	37.8	3/91	16
NA	0.0	138.0	5.2	3.8	NM	NA	31.2	0.0	12/91	--
48.2	28.4	172.5	57.0	4.9	44.6	2.08	45.5	46.2	12/91	--
76.8	12.9	694.8	38.6	32.1	49.3	4.84	0.0	8.0	12/91	6
50.3	29.5	135.6	15.9	7.9	12.5	7.19	2.2	10.5	5/91	6
56.9	23.6	123.5	6.6	16.1	18.4	3.53	22.3	40.5	9/91	2
52.0	17.8	178.6	4.3	29.9	150.5	1.69	45.0	42.6	12/91	15
60.4	26.6	120.1	1.4	21.0	14.0	1.26	73.6	43.9	12/91	--
42.6	38.5	164.1	-25.3	15.3	NM	2.36	17.1	51.1	12/91	16
28.3	49.2	160.6	1.2	35.2	-14.8	1.33	24.7	37.2	6/91	16
15.7	47.6	151.6	-8.4	61.5	NM	2.0	11.6	36.1	12/91	16
60.5	22.4	76.0	3.4	6.4	58.8	1.65	41.8	25.2	9/91	2
86.3	16.8	92.5	-13.0	-1.2	NM	2.1	4.4	25.3	9/91	8
46.6	31.2	238.9	-16.6	33.5	NM	3.05	0.5	45.3	5/91	2
76.5	17.4	358.7	8.6	13.1	NM	2.39	45.9	0.0	3/91	6
76.8	18.3	237.4	2.4	8.1	1.6	3.64	28.5	0.0	1/92	6
71.9	14.9	116.2	5.9	5.0	5.2	2.71	29.2	20.8	6/91	13
74.1	14.0	119.7	1.0	37.9	-11.7	1.93	55.5	38.7	12/91	--
75.2	9.5	126.2	1.6	10.5	-25.0	3.89	41.3	66.6	12/91	14
47.1	26.4	116.8	10.2	12.5	13.5	1.94	39.2	43.1	9/91	--
61.5	21.6	138.9	-19.8	34.4	NM	1.28	71.7	28.3	9/91	14
63.3	22.0	135.0	7.9	17.5	23.9	2.56	35.1	37.0	12/91	--
36.7	25.6	238.0	41.4	39.3	48.1	4.3	0.0	24.8	12/91	11
88.5	6.2	173.0	2.1	-3.8	NM	2.87	NM	0.0	12/91	--
82.1	17.0	517.3	-23.1	10.0	NM	4.09	56.2	0.0	11/91	4
70.0	17.1	119.1	1.3	23.4	NM	1.96	58.2	38.7	12/91	--
44.2	30.6	145.2	10.3	69.0	77.3	3.55	8.5	29.7	12/91	1
82.2	6.2	124.5	4.3	44.6	NM	1.49	28.4	0.0	8/91	--
71.8	18.1	99.3	4.5	-0.7	82.1	3.03	24.5	0.0	9/91	7,8
65.9	32.9	267.1	-83.3	-2.9	NM	0.48	NM	19.1	12/91	13
63.8	30.8	237.5	5.3	19.5	5.8	1.57	33.6	65.2	7/91	--
33.9	35.4	172.7	-1.6	71.8	NM	2.36	15.7	13.4	6/91	10
82.1	14.7	314.5	-56.1	-2.2	NM	2.74	20.5	40.8	12/91	3
59.3	23.9	228.6	13.6	26.3	20.6	2.66	19.7	39.7	9/91	14
57.6	24.2	130.4	8.5	3.1	19.1	3.14	39.6	9.3	12/91	--
57.1	28.4	118.3	3.1	10.9	-1.6	1.95	22.5	27.9	12/91	--
30.2	14.7	147.5	17.6	41.3	-8.0	3.45	2.4	25	12/91	15
79.4	12.6	82.0	2.7	5.3	-3.0	2.82	0.0	0.0	3/91	8
44.5	25.3	121.0	9.1	15.4	13.0	2.95	22.1	12.9	10/91	2
8.9	43.7	215.4	45.4	39.2	37.9	4.34	0.0	7.4	1/92	16
55.9	26.2	175.2	11.5	17.1	NM	2.25	14.4	61.6	12/91	11

(Continued)

Rank 1991	Rank 1990	Company Location	Calendar year 1991: Electronics sales ($ millions)	Total sales ($ millions)	Net profits ($ millions)	Profits as a percentage of sales	Fiscal year 1991: Return on assets	Return on equity	Return on investment
151	116	**MAI Systems** Tustin,Calif.	$283	$283.1	$-59.8	-21.1%	-23.5%	NM	NM
152	133	**Augat** Mansfield,Mass.	282	281.6	-22.1	-7.8	-7.5	-12.5	-9.2
153	142	**Olin** Stamford,Conn.	280	2275.0	-13.0	-0.6	-0.6	-2.0	-1.0
154		**Komag** Milpitas,Calif.	279	279.2	17.2	6.2	5.4	7.5	6.6
155	129	**Watkins-Johnson** Palo Alto,Calif.	278	277.5	-22.4	-8.1	-10.5	-19.0	-14.9
156	152	**Ball** Muncie,Ind.	275	2267.4	66.2	2.9	4.2	12.0	6.3
157	187	**Sensormatic** Deerfield Beach,Fla.	274	274.4	27.8	10.1	5.9	11.1	9.7
158	166	**Ametek** Paoli,Pa.	270	715.1	38.0	5.3	6.2	18.0	8.8
159	140	**Executone** Darien,Conn.	267	266.6	1.0	0.4	0.6	1.7	0.8
160	139	**Thomas & Betts** Bridgewater,N.J.	266	566.4	48.5	8.6	8.1	13.3	9.5
161	153	**Millipore** Bedford,Mass.	265	748.0	60.4	8.1	7.7	12.6	9.0
162	150	**Bolt Beranek and Newman** Cambridge	263	262.9	4.9	1.9	5.0	20.4	19.2
163		**Cabletron Systems** Rochester,N.H.	263	262.6	52.4	19.9	23.4	25.6	25.6
164	144	**Tyco Laboratories** Exeter,N.H.	260	3076.6	98.3	3.2	4.9	13.0	6.9
165	109	**Atari** Sunnyvale,Calif.	258	258.0	23.7	9.2	9.3	18.8	12.7
166	148	**Datapoint** San Antonio,Tex.	258	257.9	6.6	2.6	2.3	7.5	3.6
167	143	**Gerber Scientific** South Windsor,Conn.	257	257.0	7.3	2.9	2.8	3.8	3.4
168	164	**International Rectifier** El Segundo,Calif.	255	254.9	14.6	5.7	6.9	9.6	8.3
169	151	**Measurex** Cupertino,Calif.	254	254.0	0.4	0.2	0.1	0.2	0.2
170	167	**Bell Industries** Los Angeles,Calif.	253	401.2	-1.0	-0.3	0.4	0.7	0.5
171	154	**Reynolds and Reynolds** Dayton,Ohio	250	591.7	25.6	4.3	4.4	9.1	7.6
172	135	**Textron** Providence,R.I.	250	7840.0	300.0	3.8	1.9	10.2	2.9
173		**SynOptics Communications** Santa Clara	248	248.3	26.8	10.8	16.3	19.8	19.4
174	174	**Fluke** Everett,Wash.	246	245.6	4.1	1.7	1.9	2.8	2.7
175	134	**Concurrent Computer** Oceanport,N.J.	238	238.0	-46.7	-19.6	-31.3	NM	NM
176		**Exabyte** Boulder,Co	234	234.1	32.2	13.8	21.5	28.7	28.7
177		**EMC** Hopkinton,Mass	232	232.4	13.0	5.6	6.9	10.4	8.8
178	182	**Hubbell** Orange,Conn.	231	756.1	90.6	12.0	13.2	17.5	17.2
179		**Zeos International** St. Paul,Minn	231	230.9	10.3	4.5	10.3	16.0	16.0
180		**Adobe Systems** Mountain View,Calif.	230	229.7	51.6	22.5	23.3	28.2	28.2
181	158	**CTS** Elkhart,Ind.	230	229.5	4.2	1.8	2.4	3.4	2.9
182		**Advanced Logic Research** Irvine,Calif.	227	227.5	12.1	5.3	10.8	17.1	14.3
183	170	**Esterline** Bellevue,Wash.	225	337.6	6.7	2.0	2.9	9.5	3.9
184	193	**Pyramid Technology** Mountain View,Calif.	222	221.6	-11.1	-5.0	5.4	6.9	6.7
185	168	**Sun Electric** Crystal Lake,Ill.	220	220.4	-10.6	-4.8	-6.5	-12.0	-9.9
186	181	**Qume** Milpitas,Calif.	220	219.7	13.8	6.3	-18.9	-58.0	-31.5
187	191	**Silicon Valley Group** San Jose,Calif.	218	217.6	0.3	0.2	0.9	1.6	1.4
188	157	**Figgie International** Willoughby,Ohio	217	1208.2	30.1	2.5	2.9	7.9	3.7
189	156	**Genicom** Waynesboro,Va.	217	217.0	-16.7	-7.7	-12.2	-60.2	-18.2
190		**Harnischfeger Industries** Brookfield,Wisc.	217	1535.7	61.5	4.0	4.3	10.9	8.5
191		**Legent** Vienna,Virg	216	216.1	10.6	4.9	12.4	15.2	14.8
192		**Read-Rite** Milpitas,Calif.	216	215.9	27.5	12.7	15.0	51.2	39.6
193	161	**AM International** Chicago,Ill.	215	752.5	-6.7	-0.9	1.5	4.8	2.9
194	198	**Coherent** Palo Alto,Calif.	214	214.2	0.9	0.4	0.1	0.2	0.2
195	163	**Sequent Computer Systems** Beaverton,Ore.	213	213.3	-48.7	-22.8	-19.8	-32.6	-24.1
196	188	**Tellabs** Lisle,Ill.	213	212.8	6.6	3.1	3.6	4.6	4.4
197		**Syntex** Palo Alto,Calif	210	1957.5	451.0	23.0	18.6	42.2	26.7
198		**Telxon** Akron,Ohio	206	206.1	14.9	7.2	7.4	12.1	9.5
199		**Fischer & Porter** Warminister,Penn.	204	237.0	-22.5	-9.5	-14.6	-49.7	-29.6
200	195	**Integrated Device Technology** Santa Clara	204	203.6	-21.3	-10.5	0.5	0.9	0.6

NA = not available
NM = not meaningful

Compounded average annual growth rate, 1986-1991

**See 'Notes to the ELECTRONIC BUSINESS 200'

Cost of goods as a percentage of sales	SG&A as a percentage of sales	Sales per employee ($ thousands)	Profits per employee ($ thousands)	Five-year growth (Compounded average annual growth rate)		Current ratio	Debt to capital	Foreign sales as a percentage of total sales	Fiscal year ended	Industry segment code**
				Sales	Profits					
56.2%	37.0%	$127.3	$-28.7	3.7%	NM	0.41	105.0	66.2%	9/91	16
72.2	22.1	68.7	-5.4	1.6	NM	2.54	26.4	28.0	12/91	3
75.5	11.5	158.0	-0.9	5.6	NM	1.12	51.2	15.3	12/91	--
64.9	7.4	105.9	5.7	70.2	NM	2.89	11.8	57.6	12/91	14
63.5	21.7	105.9	-8.5	1.7	NM	2.44	21.3	30.4	12/91	8
80.9	7.1	170.7	5.0	15.7	2.2	1.44	47.2	11.4	12/91	--
34.9	38.8	90.4	9.3	23.9	NM	NA	13.2	39.4	5/91	1
71.3	10.4	117.2	6.2	12.8	0.9	2.32	51.1	29.6	12/91	--
58.8	30.8	121.2	0.5	NA	NA	1.28	51.5	0.0	12/91	2
54.2	23.1	75.5	6.5	8.0	3.8	2.2	28.6	46.7	12/91	--
41.0	35.9	130.0	10.5	11.0	9.1	2.31	28.5	58.4	12/91	--
52.2	26.9	118.5	4.0	8.7	-4.3	2.65	5.7	16.6	6/91	8
39.7	19.9	131.7	26.2	115.3	182.4	9.51	0.0	26.0	2/91	2
74.5	14.1	125.8	4.8	32.9	26.3	1.28	46.8	29.7	5/91	--
72.5	27.8	508.9	46.7	0.0	-1.2	3.01	32.7	86.1	12/91	4
52.2	33.2	152.5	3.1	-4.0	NM	1.39	51.5	94.4	7/91	2
51.8	33.6	157.9	4.7	6.9	-15.2	3.58	9.7	42.8	4/91	1
61.9	19.9	93.6	6.4	11.7	NM	2.51	13.4	61.1	6/91	15
59.3	24.3	100.4	0.2	5.7	-55.0	2.92	2.1	68.4	11/91	1
74.3	21.8	234.6	0.4	5.8	-25.9	4.13	36.9	0.0	6/91	6
55.6	32.1	128.6	4.8	7.6	-1.2	2.28	16.5	11.1	9/91	--
75.9	25.7	100.2	5.8	2.1	5.5	NA	71.9	44.8	12/91	--
31.0	34.9	258.9	28.0	167.9	NM	4.72	1.7	30.0	12/91	2
48.3	30.1	108.2	1.4	2.8	-23.5	2.69	0.8	35.0	9/91	9
50.0	28.5	127.5	-33.4	38.0	NM	0.47	159.4	41.8	6/91	12
57.2	10.6	295.9	39.4	NA	NM	3.57	0.2	14.5	12/91	14
50.7	27.8	201.2	11.3	28.4	-6.8	2.55	14.8	26.0	12/91	14
64.3	17.1	136.7	16.4	6.2	10.7	3.1	1.5	9.1	12/91	--
75.8	16.0	310.4	13.8	186.3	152.6	2.69	0.0	0.0	12/91	5
12.4	32.6	327.6	73.6	70.2	70.3	4.38	0.0	0.0	11/91	16
76.7	15.7	47.4	0.9	-1.3	NM	2.31	14.5	25.7	12/91	3
70.0	14.4	326.1	21.1	109.1	136.3	3.35	16.7	32.2	9/91	5
55.6	31.9	100.3	2.1	8.3	52.1	1.23	58.6	32.0	10/91	9
44.8	28.9	191.1	10.1	39.2	NM	3.11	2.3	26.0	9/91	10
57.1	40.5	100.0	-4.8	5.6	NM	1.97	17.7	59.5	12/91	9
86.3	15.2	228.5	-20.6	33.1	NM	1.73	45.6	41.4	2/91	14
60.2	21.6	146.3	1.0	53.2	-8.8	2.22	9.0	37.7	9/91	--
73.9	16.0	88.2	2.2	4.9	-5.9	2.39	53.1	0.0	12/91	--
67.6	19.5	86.4	-6.7	6.6	NM	2.07	69.7	36.1	12/91	14
77.4	12.2	136.6	5.6	17.3	7.4	1.66	21.9	53.1	10/91	--
NA	58.4	178.6	29.7	30.6	27.1	5.26	2.6	37.8	9/91	16
66.8	6.8	70.8	9.2	103.3	NA	1.99	22.7	27.9	9/91	3
67.7	24.1	144.0	1.5	9.8	NM	1.3	40.9	49.4	7/91	--
54.5	29.5	130.4	0.1	8.5	NM	2.34	15.3	5.01	9/91	9
41.1	46.7	156.4	-35.7	60.5	NM	1.76	26.0	45.8	12/91	10
48.3	27.1	101.6	3.2	12.9	-4.6	4.04	3.1	36.9	12/91	2
14.3	37.0	166.7	38.9	13.1	15.3	1.48	36.7	31.4	7/91	--
45.8	31.5	153.8	10.3	17.6	9.4	3.86	21.4	33.6	3/91	1
62.0	28.1	98.2	-9.3	6.0	NM	1.69	40.4	62.8	12/91	9
35.7	22.0	96.8	0.6	28.3	-17.5	2.19	35.4	13.7	3/91	15

Every industry segment tells a story

The biggest story for the electronics industry this year is plummeting profits. Profitability, as measured by the ratio of net profits to sales, actually fell in calendar year 1991 for two segments of the industry: Minicomputers was a negative 6%, and mainframes, a minus 2.4%. The minicomputer segment was the only one to suffer two consecutive years of red ink, thanks to large losses at Wang, Concurrent Computer, DEC, and Tandem Computer. Three segments improved profitability: instruments (up 0.6 percentage points); computer-based systems (up 0.2 points); and the perennial favorite, software (up only 0.1 points, but still number one at 10%).

Despite all the attention to cost cutting, only four segments reduced manufacturing costs as a share of sales from fiscal 1990 to 1991. The star performers were communications (down 7.2 points) and semiconductors (down 4.4 points). Component and minicomputer makers also reined in their group costs slightly. The laggards were software and distribution, where weighted average costs as a share of sales rose 5.4 points each. Year-to-year comparisons in the distribution segment, however, may be misleading. This year, the definition of distribution was broadened to include distributors of computers as well as components, so two new companies—Merisel and Tech Data—were added to the list. (For more about confusion with industry segment comparisons, see "Notes to the ELECTRONIC BUSINESS 200.")

Productivity, as measured by sales per employee, rose nearly across the board. Only the consumer electronics segment failed to perform—its productivity fell 4.3% from 1990 to 1991. Distributors and desktop computer makers cranked out more money per employee than any other segment. Five—distribution, medical electronics, peripherals, semiconductors, and computer-based systems—increased productivity by more than 10%.

The march to foreign markets was fairly erratic. Six segments—semiconductors, minicomputers, components, instruments, and peripherals—increased foreign sales (as a share of total sales) by 3 points or more from 1990 to 1991. Three—consumer, government, and medical electronics—took significant steps backwards. ☐

A quick comparison of the industry segments

	Profitability (profits/sales)		Cost of goods sold (as % of sales)		Productivity (sales/employee)		Foreign sales (as % of sales)	
Segment (# of companies)	**1990**	**1991**	**1990**	**1991**	**1990**	**1991**	**1990**	**1991**
Computer-based systems (7)	5.6%	5.8%	49.5%	50.1%	$141,100	$157,700	52.9%	54.4%
Communications (13)	4.0	3.3	55.3	48.1	110,300	116,700	48.2	49.1
Components (9)	6.5	4.4	62.5	62.1	86,900	89,800	51.7	55.2
Consumer electronics (5)	2.5	1.0	65.2	66.0	108,900	104,200	10.0	8.9
Desktop computers (11)	8.3	4.5	50.0	53.4	263,600	286,000	47.1	47.6
Distribution (10)	3.9	2.7	72.3	77.7	255,900	313,300	0.0	2.2
Diversified (8)	7.5	0.9	42.3	44.8	157,500	165,700	56.2	57.0
Government (13)	3.7	2.5	71.7	73.5	107,500	111,000	21.3	15.0
Instruments (10)	3.1	3.7	58.5	60.2	108,500	113,100	37.8	41.1
Mainframes (8)	6.9	-2.4	40.9	42.7	169,000	179,300	58.5	59.6
Medical electronics (6)	8.6	7.7	40.2	44.8	133,000	154,200	42.4	35.2
Minicomputers (6)	-3.8	-6.0	44.7	44.5	112,900	122,600	54.8	58.4
Office equipment (4)	4.7	3.6	42.6	45.3	131,000	132,400	44.6	44.5
Peripherals (15)	3.3	1.2	70.2	72.5	104,400	118,200	39.6	42.7
Semiconductors (12)	3.3	3.2	57.6	53.2	100,700	113,200	44.7	48.5
Software (13)	9.9	10.0	15.8	21.2	173,700	186,300	48.6	49.3

All data are weighted averages based on fiscal years, except profitabiltiy, which is based on calendar years. For a list of companies in each segment, see accompanying detailed industry segment tables.

Source: ELECTRONIC BUSINESS

ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal year 1991

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
1 -Industry segment code **COMPUTER-BASED SYSTEMS**									
Diebold	104	$131.2	5	62.7%	7	1.8%	7	21.9%	7
Gerber Scientific	167	157.9	2	51.8	5	2.4	6	42.8	3
Hewlett-Packard	3	162.9	1	49.9	4	5.9	1	55.9	2
Measurex	169	100.4	6	59.3	6	3.2	5	68.4	1
Sensormatic Electronics	157	90.4	7	34.9	1	5.9	1	39.4	4
Symbol Technologies	136	145.2	4	44.2	2	5.4	3	29.7	6
Telxon	198	153.8	3	45.8	3	4.1	4	33.6	5
Weighted average		157.7		50.1		5.7		54.4	
2 -Industry segment code **COMMUNICATIONS**									
3Com	123	238.9	2	46.6	5	6.7	5	45.3	3
ADC Telecommunications	148	121.0	10	44.5	4	8.4	2	12.9	11
Andrew	115	123.5	8	56.9	9	6.0	6	40.5	4
Cabletron Systems	163	131.7	7	39.7	2	8.0	4	26.0	8
Datapoint	166	152.5	5	52.2	8	3.8	10	94.4	1
DSC Communications	101	141.5	6	58.4	10	4.8	7	10.4	12
Dynatech	99	152.8	4	42.8	3	3.5	11	30.4	6
Executone	159	121.2	9	58.8	11	0.6	13	0.0	13
Motorola	7	111.2	11	46.6	6	11.6	1	55.9	2
M/A-Com	121	76.0	13	60.5	12	4.5	8	25.2	9
Scientific Atlanta	95	164.6	3	68.1	13	4.0	9	22.0	10
SynOptics Communications	173	258.9	1	31.0	1	8.4	2	30.0	7
Tellabs	196	101.6	12	48.3	7	3.3	12	36.9	5
Weighted average		116.7		48.1		9.9		49.1	
3 -Industry segment code **COMPONENTS**									
AMP	31	123.8	2	58.6	2	10.1	3	60.5	2
Amphenol	98	86.6	4	60.7	3	2.0	9	41.7	5
Applied Magnetics	109	45.5	9	75.1	7	7.8	4	56.2	3
Augat	152	68.7	6	72.2	6	5.1	8	28.0	7
CTS	181	47.4	8	76.7	8	7.0	6	25.7	9
Molex	81	101.8	3	49.6	1	15.4	2	75.8	1
Read-Rite	192	70.8	5	66.8	5	20.1	1	27.9	8
Sprague Technologies	142	314.5	1	82.1	9	7.7	5	40.8	6
Vishay Intertechnology	108	50.8	7	65.8	4	6.0	7	51.9	4
Weighted average		89.8		62.1		9.5		55.2	
4 -Industry segment code **CONSUMER**									
Atari	165	508.9	3	72.5	2	0.8	4	86.1	1
Audiovox	134	517.3	2	82.1	3	1.2	3	0.0	–
Emerson Radio	79	929.7	1	94.0	5	0.6	5	0.0	–
Tandy	16	114.0	4	53.0	1	3.1	1	7.8	2
Zenith Electronics	52	47.7	5	88.6	4	2.8	2	4.8	3
Weighted average		104.2		66.0		2.6		8.9	

Fiscal year 1991

-Industry segment code

5 DESKTOP COMPUTERS

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Advanced Logic Research	182	$326.1	3	70.0%	8	1.6%	9	32.2%	9
Apple Computer	11	437.1	1	49.3	4	3.5	6	44.8	6
AST Research	77	232.6	8	62.3	6	1.3	10	40.1	7
Compaq Computer	22	327.1	2	57.7	5	5.8	4	57.6	2
Dell Computer	70	296.6	5	66.7	7	3.7	5	36.4	8
Everex Systems	96	186.0	10	77.1	10	2.4	7	17.4	10
Intergraph	57	116.1	11	45.0	2	7.7	2	46.4	5
Silicon Graphics	87	220.0	9	40.4	1	8.6	1	52.8	3
Sun Microsystems	20	257.7	7	47.7	3	6.0	3	51.4	4
Tandon	102	278.6	6	77.6	11	2.0	8	78.6	1
Zeos International	179	310.4	4	75.8	9	1.2	11	0.0	–
Weighted average		286.0		53.4		4.6		47.6	

-Industry segment code

6 DISTRIBUTION

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Anthem Electronics	113	694.8	3	76.8	6	1.4	1	8.0	2
Arrow Electronics	62	248.5	6	77.9	8	0.4	9	0.0	–
Avnet	48	240.1	7	74.3	2	1.2	3	0.0	–
Bell Industries	170	234.6	9	74.3	2	1.4	1	0.0	–
Marshall Industries	90	364.2	4	76.0	4	1.2	3	0.0	–
Merisel	46	1093.4	1	89.9	10	0.3	10	4.6	3
Pioneer-Standard Electronics	124	358.7	5	76.5	5	1.2	3	0.0	–
Premier Industrial	114	135.6	10	50.3	1	0.9	7	10.5	1
Tech Data	86	937.6	2	89.2	9	0.6	8	0.0	–
Wyle Laboratories	125	237.4	8	76.8	6	1.1	6	0.0	–
Weighted average		313.3		77.7		0.8		2.2	

-Industry segment code

7 DIVERSIFIED

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Control Data	54	117.3	4	59.7	3	2.2	6	35.1	4
Cubic	138	99.3	6	71.8	8	1.1	8	0.0	–
Harris	26	99.0	7	61.4	5	4.4	3	30.2	6
Hewlett-Packard	3	162.9	2	49.9	2	5.9	2	55.9	2
Honeywell	12	106.4	5	66.3	7	3.9	5	33.8	5
IBM	1	188.1	1	39.7	1	10.0	1	62.3	1
Mark IV Industries	89	82.2	8	60.4	4	2.1	7	20.1	7
Varian Associates	50	148.2	3	64.0	6	4.3	4	44.3	3
Weighted average		165.7		44.8		8.5		57.0	

-Industry segment code

8 GOVERNMENT

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Bolt Beranek and Newman	162	118.5	3	52.2	1	4.0	6	16.6	8
Cubic	138	99.3	9	71.8	5	1.1	13	0.0	–
ESCO Electronics	122	92.5	11	86.3	13	2.1	11	25.3	5
E-Systems	39	106.9	5	82.6	12	2.6	10	8.8	9
GM Hughes Electronics	6	124.1	2	73.1	6	5.9	2	0.0	–
Harris	26	99.0	10	61.4	3	4.4	4	30.2	3
Litton Industries	24	99.8	8	73.2	7	4.9	3	25.8	4
Logicon	147	82.0	13	79.4	11	1.3	12	0.0	–
Loral	27	89.5	12	61.1	2	4.4	4	20.7	6
Martin Marietta	25	101.4	7	77.1	10	3.5	9	0.0	–
Raytheon	13	129.5	1	76.0	9	3.8	7	17.7	7
Texas Instruments	10	107.8	4	74.8	8	7.4	1	35.1	1
Watkins-Johnson	155	105.9	6	63.5	4	3.6	8	30.4	2
Weighted average		111.0		73.5		4.9		15.0	

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Industry segment code **9** **INSTRUMENTS & MEASUREMENT**									
Coherent	194	$130.4	3	54.5%	5	3.4%	5	51.0%	4
Esterline	183	100.3	8	55.6	6	2.0	10	32.0	10
Fischer & Porter	199	98.2	10	62.0	8	2.7	8	62.8	2
Fluke	174	108.2	6	48.3	3	4.2	3	35.0	8
Honeywell	12	106.4	7	66.3	10	3.9	4	33.8	9
Perkin-Elmer	82	137.6	2	47.7	2	3.3	6	64.3	1
Sun Electric	185	100.0	9	57.1	7	2.2	9	59.5	3
Tektronix	53	111.4	5	43.9	1	5.1	1	49.7	5
Teradyne	93	118.4	4	51.0	4	2.9	7	47.0	6
Varian Associates	50	148.2	1	64.0	9	4.3	2	42.6	7
Weighted average		113.1		60.2		3.9		41.1	
Industry segment code **10** **MAINFRAMES**									
Amdahl	43	181.1	3	53.5	6	19.3	1	40.9	5
Control Data	54	117.3	8	59.7	7	2.2	8	35.1	6
Cray Research	72	159.9	5	22.7	1	5.4	6	55.1	2
IBM	1	188.1	2	39.7	3	10.0	4	62.3	1
Pyramid Technology	184	191.1	1	44.8	5	11.5	3	26.0	7
Sequent Computer Systems	195	156.4	6	41.1	4	12.3	2	45.8	4
Teradata	141	172.7	4	33.9	2	9.5	5	13.4	8
Unisys	9	144.2	7	62.3	8	2.9	7	51.0	3
Weighted average		179.3		42.7		9.2		59.6	
Industry segment code **11** **MEDICAL**									
Acuson	132	238.0	1	36.7	2	4.1	4	24.8	5
Beckman Instruments	75	124.3	6	42.2	3	7.9	1	55.6	2
Diasonics	150	175.2	3	55.9	5	3.4	5	61.6	1
Fisher Scientific	100	236.8	2	67.1	6	0.4	6	0.0	6
Medtronic	71	135.1	5	27.9	1	6.4	2	42.1	3
Westmark International	94	136.0	4	49.2	4	4.7	3	31.0	4
Weighted average		154.2		44.8		4.9		35.2	
Industry segment code **12** **MINICOMPUTERS**									
Concurrent Computer	175	127.5	4	50.0	6	3.0	6	41.8	6
Data General	56	144.6	3	45.1	3	6.7	3	52.0	4
Digital Equipment	4	115.0	6	46.4	4	5.3	5	60.4	1
Stratus Computer	107	180.0	1	31.5	2	7.0	2	47.4	5
Tandem Computers	41	172.1	2	31.0	1	7.2	1	55.6	3
Wang Laboratories	40	124.6	5	46.6	5	6.2	4	55.8	2
Weighted average		122.6		44.5		5.7		58.4	
Industry segment code **13** **OFFICE EQUIPMENT**									
Pitney Bowes	37	113.3	4	28.2	1	7.5	1	22.5	2
Savin	139	267.1	1	65.9	3	7.2	2	19.1	4
Smith Corona	126	116.2	3	71.9	4	1.9	3	20.8	3
Xerox (data processing only)	5	137.0	2	48.2	2	1.9	3	51.0	1
Weighted average		132.4		45.3		1.6		17.7	

Company	200 rank	Sales per employee ($ thousands)	rank	Cost of goods sold as a percentage of sales	rank	Capital expenditures as a percentage of sales	rank	Foreign sales as a percentage of sales	rank
Industry segment code **14 PERIPHERALS**									
Archive	130	$138.9	10	61.5%	5	1.9%	15	28.3%	11
Conner Peripherals	45	195.0	6	77.1	11	5.5	5	63.6	2
EMC	177	201.2	5	50.7	1	8.5	2	26.0	13
Everex Systems	96	186.0	7	77.1	11	2.4	13	17.4	14
Exabyte	176	295.9	2	57.2	2	2.9	11	14.5	15
Genicom	189	86.4	14	67.6	7	3.2	10	36.1	10
Komag	154	105.9	12	64.9	6	19.5	1	57.6	4
Maxtor	66	104.9	13	82.8	14	5.3	6	26.8	12
Micropolis	128	126.2	11	75.2	9	4.7	8	66.6	1
QMS	143	228.6	3	59.3	3	2.7	12	39.7	7
Quantum	60	607.4	1	74.0	8	5.2	7	44.7	5
Qume	186	228.5	4	86.3	15	2.3	14	41.4	6
Seagate Technology	21	62.3	15	75.7	10	3.4	9	36.4	9
Storage Technology	58	156.9	8	61.2	4	7.0	4	39.2	8
Western Digital	67	146.3	9	78.0	13	7.8	3	60.3	3
Weighted average		118.2		72.5		5.3		42.7	
Industry segment code **15 SEMICONDUCTORS**									
Advanced Micro Devices	55	109.0	6	41.0	5	9.1	8	56.6	2
Analog Devices	92	103.4	9	40.9	4	9.7	7	53.8	4
Cypress Semiconductor	146	147.5	4	30.2	1	22.6	1	25.0	11
Integrated Device Technology	200	96.8	10	35.7	2	17.9	3	13.7	12
Intel	14	194.3	1	39.7	3	19.8	2	51.3	5
International Rectifier	168	93.6	11	61.9	10	5.6	12	61.1	1
LSI Logic	84	166.0	3	54.5	8	10.6	6	47.5	7
Micron Technology	103	103.9	8	57.0	9	12.2	4	26.0	10
Motorola	7	111.2	5	46.6	6	11.6	5	55.9	3
National Semiconductor	44	57.1	12	65.4	11	6.5	11	51.3	5
Texas Instruments	10	107.8	7	74.8	12	7.4	10	35.1	9
VLSI Technology	116	178.6	2	52.0	7	7.9	9	42.6	8
Weighted average		113.2		53.2		11.6		48.5	
Industry segment code **16 SOFTWARE**									
Adobe Systems	180	327.6	1	12.4	2	5.3	8	0.0	13
Ask Computer Systems	119	160.6	10	28.3	8	1.8	12	37.2	10
Autodesk	149	215.4	5	8.9	1	3.6	10	7.4	12
Borland International	110	230.0	2	17.8	7	12.4	3	37.8	8
Cadence Design Systems	120	151.6	11	15.7	6	7.6	5	36.1	11
Computer Associates	49	201.2	6	NA	–	1.4	13	53.2	4
Legent	191	178.6	8	NA	–	6.7	6	37.8	8
Lotus Development	76	192.8	7	12.5	3	4.7	9	50.8	6
MAI Systems	151	127.3	13	56.2	10	2.0	11	66.2	1
Mentor Graphics	118	164.1	9	42.6	9	7.8	4	51.1	5
Microsoft	38	224.1	4	15.6	5	14.3	1	57.3	3
Novell	83	225.1	3	15.5	4	13.6	2	43.8	7
Oracle Systems	59	137.7	12	72.7	11	5.9	7	61.6	2
Weighted average		186.3		21.2		7.5		49.3	

NA=Not available
Includes only companies with electronics sales over 50% of total
See "Notes to the ELECTRONIC BUSINESS 200" on page XX

Source: ELECTRONIC BUSINESS

Notes to the ELECTRONIC BUSINESS 200

Sales
Sales include revenue from products, services, and rentals, but exclude dividends, interest, and other non-operating revenue at calendar year end.

Profits
Profits are income from continuing operations after taxes and before extraordinary items or charges as shown on the income statement at calendar year end.

Debt to total capital
Debt to total capital is the ratio of long-term plus short-term debt to shareholders' equity plus long-term and short-term debt at fiscal year end.

Return on equity
ROE is profits as a percentage of shareholders' equity (preferred stock, capital stock, surpluses, and retained earnings) at fiscal year end.

Current ratio
Current ratio is the ratio of current assets to current liabilities at fiscal year end and is one measure of a company's ability to pay its debts. Lenders prefer to see a current ratio of 2:1 or more.

Return on investment
ROI is profits as a percentage of shareholders' equity plus both short-term (current portion of long-term debt, notes payable, and other borrowings) and long-term debt at fiscal year end.

Cost of goods sold
COGS includes manufacturing costs of products, services, and rentals sold, minus depreciation. COGS is expressed as a percentage of total sales at fiscal year end.

Foreign sales
Foreign sales include export revenue from U.S. operations plus sales from operations outside the U.S. to unaffiliated customers at fiscal year end.

Employees
The number of employees is supplied by each company and may represent head count at fiscal year end or average head count for the entire 12-month period.

SG&A
Selling, general, and administrative costs include all marketing and other administrative costs. SG&A costs are expressed as a percentage of total sales at fiscal year end.

Return on assets
ROA is profits as a percentage of total assets at fiscal year end.

Industry segment classification

Companies are classified in the industry segments that represent the greatest volume of their sales. For purposes of comparison, only companies with electronics sales comprising 50% or more of their total sales are included in the industry segment tables. (Prior to 1991, electronics sales of 70% or more of total sales were required.)

Comparisons between companies in like industry segments may be misleading for several reasons. One, often a company classified in one segment has a large proportion of sales from other segments, which makes comparisons with pure-play companies confusing. Two, as companies sell off or acquire divisions, the data changes drastically from year to year. Three, comparisons between companies that contract out major business functions and those that don't will often be misleading as well.

Industry segment codes

1 Computer-based systems
2 Communications equipment
3 Components (excluding semiconductors)
4 Consumer electronics
5 Desktop computers
6 Distribution
7 Diversified electronics
8 Government & military electronics
9 Instruments & measurement
10 Mainframes
11 Medical electronics
12 Minicomputers
13 Office equipment
14 Peripherals
15 Semiconductors
16 Software

Newcomers to the 200

Company	1991 Rank
Adobe Systems	180
Advanced Logic Research	182
Amphenol	98
Black & Decker	117
Cabletron Systems	163
EMC	177
Exabyte	176
Fischer & Porter	199
Fisher Scientific International	100
Harnischfeger Industries	190
Komag	154
Legent	191
Merisel	46
Read-Rite	192
SynOptics Communications	173
Syntex	197
Tech Data	86
Telxon	198
Zeos International	179

Displaced from the 200

Company	1990 Rank
Allen Group	179
Anacomp	183
Ashton-Tate	177
Bally Manufacturing	146
BancTec	200
Chips and Technologies	147
Cincinnati Milacron	173
Convex Computer	190
Cooper Industries	169
Encore Computer	185
General DataComm Industries	194
Kollmorgen	186
Morton International	196
NCR	12
Northgate Computer	192
Recognition Equipment	189
Square D	165
Ultimate	197
United Telecommunications	99

A note about R&D and capital spending

More detailed R&D data are available in this issue's top 100 R&D spenders ranking. Capital spending data will also be available in next month's top 100 capital spenders ranking.

ELECTRONIC BUSINESS 200

ALPHABETIC INDEX

Company	Rank
3Com Corp	123
3M Co	19
Acuson	132
ADC Telecommunications Inc	148
Adobe Systems Inc	180
Advanced Logic Research Inc	182
Advanced Micro Devices Inc	55
Allied-Signal Inc	29
AM International Inc	193
Amdahl Corp	43
Ametek Inc	158
AMP Inc	31
Amphenol Corp	98
Analog Devices Inc	92
Andrew Corp	115
Anthem Electronics Inc	113
Apple Computer Inc	11
Applied Magnetics Corp	109
Applied Materials Inc	85
Archive Corp	130
Arrow Electronics Inc	62
Ask Computer Systems Inc	119
AST Research Inc	77
AT&T	2
Atari Corp	165
Audiovox Corp	134
Augat Inc	152
Autodesk	149
Avnet Inc	48
Ball Corp	156
Beckman Instruments Inc	75
Becton Dickinson and Co	129
Bell Industries Inc	170
Black & Decker	117
Boeing Co The	35
Bolt Beranek and Newman Inc	162
Borland International	110
Cabletron Systems Inc	163
Cadence Design Systems Inc	120
Chrysler Corp	63
Coherent Inc	194
Compaq Computer Corp	22
Computer Associates International Inc	49
Concurrent Computer Corp	175
Conner Peripherals Inc	45
Control Data Corp	54
Corning Inc	68
Cray Research Inc	72
CTS Corp	181
Cubic Corp	138
Cypress Semiconductor Corp	146
Data General Corp	56
Datapoint Corp	166
Dell Computer Corp	70
Diasonics Inc	150
Diebold Inc	104
Digital Equipment Corp	4
Dover Corp	97
DSC Communications Corp	101
DuPont E I De Nemours & Co	34
Dynatech Corp	99
Eastman Kodak Co	17
Eaton Corp	69
EG&G Inc	78
Eli Lilly and Co	88
EMC Corp	177
Emerson Electric Co	36
Emerson Radio Corp	79
ESCO Electronics Corp	122
Esterline Corp	183
Everex Systems	96
Exabyte	176
Executone Information Systems Inc	159
E-Systems Inc	39
Figgie International Inc	188
Fischer & Porter Co	199
Fisher Scientific International Inc	100
Fluke Mfg Co John	174
Ford Motor Co	33
General Dynamics Corp	65
General Electric Co	8
General Signal Corp	80
Genicom Corp	189
Gerber Scientific Inc	167
GM Hughes Electronics Corp	6
Grumman Corp	61
GTE Corp	30
Harnischfeger Industries Inc	190
Harris Corp	26
Hewlett-Packard Co	3
Honeywell Inc	12
Hubbell Inc	178
IBM	1
Imo Industries Inc	135
Inmac Corp	140
Integrated Device Technology Inc	200
Intel Corp	14
Intergraph Corp	57
International Rectifier Corp	168
ITT Corp	32
Johnson Controls Inc	47
Komag Inc	154
Legent Corp	191
Litton Industries Inc	24
Lockheed Corp	18
Logicon Inc	147
Loral Corp	27
Lotus Development Corp	76
LSI Logic Corp	84
LTV Corp The	133
MAI Systems Corp	151
Mark IV Industries Inc	89
Marshall Industries	90
Martin Marietta Corp	25
Maxtor Corp	66
McDonnell Douglas Corp	42
Measurex Corp	169
Medtronic Inc	71
Mentor Graphics Corp	118
Merisel Inc	46
Micron Technology Inc	103
Micropolis Corp	128
Microsoft Corp	38
Millipore Corp	161
Molex Inc	81
Monsanto Co	106
Motorola Inc	7
M/A-COM Inc	121
National Semiconductor Corp	44
Northrop Corp	73
Novell Inc	83
Olin Corp	153
Oracle Systems Corp	59
Penn Central Corp	111
Perkin-Elmer Corp The	82
Pioneer-Standard Electronics Inc	124
Pitney Bowes Inc	37
Pittway Corp	145
Polaroid Corp	112
Premier Industrial Corp	114
Pyramid Technology Corp	184
QMS Inc	143
Quantum Corp	60
Qume Corp	186
Raychem Corp	91
Raytheon Co	13
Read-Rite Corp	192
Reliance Electric Co	105
Reynolds and Reynolds Co The	171
Rockwell International Corp	15
Savin Corp	139
SCI Systems Inc	64
Scientific Atlanta Inc	95
Seagate Technology Inc	21
Sensormatic Electronics Corp	157
Sequa Inc	127
Sequent Computer Systems Inc	195
Silicon Graphics Inc	87
Silicon Valley Group Inc	187
Smith Corona Corp	126
Solectron Corp	137
Sprague Technologies Inc	142
Storage Technology Corp	58
Stratus Computer Inc	107
Sun Electric Corp	185
Sun Microsystems Inc	20
Sundstrand Corp	144
Symbol Technologies Inc	136
SynOptics Communications Inc	173
Syntex Corp	197
Tandem Computers Inc	41
Tandon Corp	102
Tandy Corp	16
Tech Data Corp	86
Tektronix Inc	53
Teledyne Inc	74
Tellabs Inc	196
Telxon Corp	198
Teradata Corp	141
Teradyne Inc	93
Texas Instruments Inc	10
Textron Inc	172
Thermo Electron Corp	131
Thomas & Betts Corp	160
TRW Inc	28
Tyco Laboratories Inc	164
Unisys Corp	9
United Technologies Corp	51
Varian Associates Inc	50
Vishay Intertechnology Inc	108
VLSI Technology Inc	116
Wang Laboratories Inc	40
Watkins-Johnson Co	155
Western Digital Corp	67
Westinghouse Electric Corp	23
Westmark International Inc	94
Wyle Laboratories Inc	125
Xerox Corp	5
Zenith Electronics Corp	52
Zeos International Ltd	179

HOW Linear Technology gets the biggest bang for its R&D bucks

As leader of National Semiconductor's analog products group back in the late '70s and early '80s, Robert Swanson ran what was then the largest linear IC business in the industry. It was there, he claims, that he discovered one of the principles in the success of Linear Technology: the careful management of R&D spending.

Linear has grown to more than $100 million in revenue while posting profits that have made the company a darling on Wall Street. His philosophy is simple: All R&D spending is not an investment in the future—it can be a black hole just like other expenses and must be carefully managed to maximize results and avoid waste. So far, it works. Spending only 10% of sales, Linear leads the analog market in performance and posts 25% profit margins. Net sales for 1991 were $94.2 million with gross profit of $52.3 million.

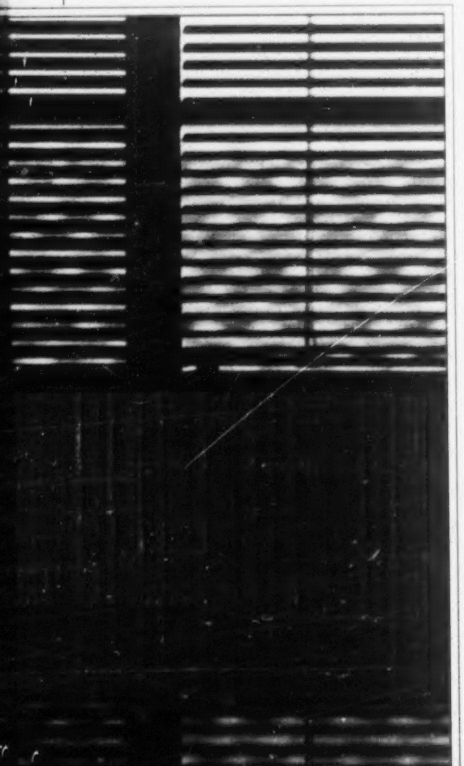
By Hugh Willett

Photos by Jamie Tanaka

ELECTRONIC BUSINESS: How much does Linear spend on R&D?
ROBERT SWANSON: In fiscal 1992 we spent about $7.7 million, and in 1993 we'll spend about $10 million.

EB: What percentage of sales does this represent?
RS: It's about 10% of our total sales. We feel that spending 10% can generate the number of new products we need to keep sales growing at the rate we want to grow. We don't specifically try to spend 10%, but that is the rate that has worked out for us.

EB: The industry average is about 15%, and some companies such as Advanced Micro Devices have been spending 20% per year. Aren't you guys spending too little?
RS: I had the benefit of working at a company like National, and I saw that you could waste money in R&D programs—a lot of money. R&D is a part of the P&L, just like marketing or other expenses that have to be managed carefully.



EB: Isn't R&D spending an investment in the future?
RS: It should be, but look at it this way: Gross profits are about 50% in this business. If you're trying to get 25% profit on the bottom line, which is what you need to survive after your 15% SG&A expenses, that doesn't leave more than 10% for R&D. I could spend more, but it would have to come off my bottom line. That's not a formula for success.

EB: What is the average return on investment in R&D for Linear?
RS: We want to see $1 million to $3 million in sales over two years for each new product. Some will do $5 million.

EB: How does this compare with others in your industry?
RS: A lot of companies in the analog business are happy to get $300,000 to $400,000 per year in sales from a product. We call those "turkeys" in our organization, and they make up less than 5% of our new products.

EB: Are there other ways to measure the progress of your investments?
RS: We can look at incremental sales two years after the investments are made. In fiscal 1987 we spent $3.3 million on R&D and in 1989 we grew sales by $13 million. That's a multiple of 3.9.

EB: How many new products come out of your R&D effort each year?
RS: Anywhere from 50 to 90. We have about 35 circuit designers plus process engineers and managers for a total R&D staff of about 75, or less than 10% of our 850 employees worldwide.

EB: How do you get such high levels of productivity out of such a small number of engineers?
RS: Each designer is working on two or three designs at a time. The analog design is more of an individual effort than a digital design. We try to establish a strong sense of ownership between a designer and the new product. The culture at Linear gives them a lot of freedom in how they design, but they're accountable for the success of the product. If it sells, you're a hero. If it doesn't, you're a bum.

EB: How many projects are considered for funding each year, and how many are actually funded?
RS: We might look at hundreds of good ideas, but we can implement only as many of them as our design resources will allow. We are constantly reprioritizing, looking at the list of projects and adding to it or taking something off the list. Designers could be working on three projects at once, or they could be working on just one if it has a high priority.

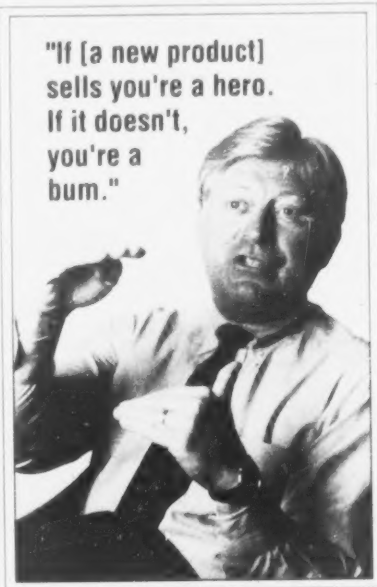
EB: If the designs are going to produce millions in revenue, why don't you just expand your design group and make more money?
RS: We have $95 million in the bank, so it's not a matter of not having the money to fund everything we'd like to design. There are natural limits.

EB: What kind of limits?
RS: Finding really talented design engineers. We don't want just good designers, we want great ones. That's how you maximize the return on R&D dollars. We're like the Marines—looking for a few good men.

EB: How long is a typical product development cycle?
RS: It can be anywhere from one to three years. Even though our customers' product life cycles are accelerating, the products we are designing are getting more complicated so

our design cycle is getting longer.

EB: Doesn't that fly in the face of the "time-to-market" race that seems to have everyone in the chip business so concerned?
RS: Our products will typically have a three-year lifespan. We are always working to improve the design, but one product—if it's the best in the industry—may serve our customers through several generations of their own products.


"If [a new product] sells you're a hero. If it doesn't, you're a bum."

EB: Isn't it hard to closely track return on investment if it takes several years to realize the full return?
RS: We make our yearly investments based on a consistent philosophy. What I spent two years ago, I expect to see in my sales this year.

EB: How does the process work?
RS: We exploit our field applications engineers. They're out talking to the customer, finding out what he needs, and planting seeds for the future. They submit written reports, and those reports are critiqued by a team that includes myself and Bob Dobkin, our director of design.

EB: Do the design engineers participate in the selection process?
RS: Our design engineers also travel a lot; we don't keep them locked away. We want them out talking to the customer so they know what kind of problems the customer is facing. We don't try to insulate our designers from the customer the way a lot of companies do. Our customers can pick up a phone any time and get one of our designers on the line.

EB: How does customer input turn into product ideas?
RS: Every week we have a meeting to sort through the reports from the field. That information is used to add features or performance to projects underway and to give us ideas for new products.

EB: How do you decide which ideas to keep?
RS: We're in the analog business, but so are about 50 other companies. We don't want to pick new products just because we know there will be a market for them, because everybody else is going to be targeting those same markets. We look for the ideas that play to our strengths in performance—low power and so on. Those are the cream that we want to skim off. The other ideas might be good, but they're down in the milk, and we don't want to play down there.

EB: How do you know which products will play to Linear's strengths?
RS: We bring everyone into the process, from the design engineers to marketing and process development and test people. We want to design to the edge of the envelope. The designer needs to communicate with the process engineer to know what kind of performance capabilities will be available a year from now. The process engineer needs to know what he'll have to be able to put in silicon in the future.

EB: Are investments in process R&D as important as in design R&D?
RS: Yes, very much so. We have our own fab because it's an asset that we rely on to provide the highest performance parts. The process engineers need to know the exact requirements so we don't over-invest.

EB: How do you over-invest?
RS: A lot of companies in the analog business spend a lot of money on process technology hoping they'll discover some magic formula. They don't know exactly what they want so they spend money to find out.

EB: How is Linear different?
RS: We find out exactly what we need before we spend. The analog business doesn't require the tightest geometries. We're making leading-edge products with 2-micron processes. That may not sound high-tech to the digital world, but it's adequate for analog. We don't want to go to submicron just to brag that we have a submicron process. Our process investments are geared to low power and high speed.

EB: Besides process and design, where else do you spend R&D money?
RS: Packaging is one area where we try to distinguish ourselves. We find out what the customer requirements are and design to those needs. □

TOP 100 R&D SPENDERS

The top 100 R&D spenders keep on spending

Despite last year's recession, the top 100 spenders on research and development actually plowed more *into R&D—both in terms of total dollars spent (from $21.2 billion in 1990 to $21.7 billion in 1991) and as a share of their sales (from 9.0% to 9.3%). Companies that boosted R&D spending significantly include Symbol Technologies (up 210%), Ask Computer Systems (81%), and Diebold (72%). For the complete listing of the* ELECTRONIC BUSINESS *top 100 R&D spenders, see page* 101.

TOP 100 R&D SPENDERS

Rank 1991	Rank 1990	Company	Location	R&D as a percentage of sales	R&D spending ($ millions)	R&D spending (% change)	1991 sales ($ millions)	% change from 1990	1991 net income ($ millions)	% change from 1990	Fiscal year
1	2	**Integrated Device Technology Inc.**	Santa Clara,Calif.	25.6%	$50.8	22.1%	$198.6	-5.2%	$1.2	-92.8%	3/91
2	1	**Cypress Semiconductor Corp.**	San Jose,Calif.	25.0	71.8	29.2	286.8	27.3	34.2	2.8	12/91
3	6	**Mentor Graphics Corp.**	Wilsonville,Ore.	19.9	79.5	6.7	400.1	-8.1	-61.6	NM	12/91
4	18	**Amdahl Corp.**	Sunnyvale,Calif.	18.4	312.5	0.8	1,702.5	-21.1	4.4	-97.6	12/91
5	15	**Tellabs Inc.**	Lisle,Ill.	17.5	37.2	17.8	212.8	0.8	6.6	-18.2	12/91
6	3	**Advanced Micro Devices Inc.**	Sunnyvale,Calif.	17.4	213.8	5.0	1,226.6	15.8	145.3	NM	12/91
7	4	**Cadence Design Systems Inc.**	San Jose,Calif.	17.4	68.3	60.4	392.3	69.5	-21.7	NM	12/91
8	8	**Analog Devices Inc.**	Norwood,Mass.	16.6	89.0	10.8	537.7	10.8	8.2	NM	10/91
9	10	**Cray Research Inc.**	Eagan,Minn.	16.4	141.3	10.0	862.5	7.2	113.0	0.0	12/91
10	7	**Applied Materials Inc.**	Santa Clara,Calif.	16.1	102.7	5.8	638.6	12.6	26.2	-23.0	10/91
11	19	**Stratus Computer Inc.**	Marlborough,Mass.	15.5	69.7	21.3	448.6	11.1	49.7	34.4	12/91
12	27	**Concurrent Computer Corp.**	Oceanport,N.J.	14.9	38.1	-11.6	254.9	-25.0	-66.8	NM	6/91
13		**Adobe Systems Inc.**	Mountain View,Calif.	14.5	33.2	64.4	229.7	36.1	51.6	28.8	11/91
14	25	**Teradata Corp.**	El Segundo,Calif.	14.4	37.2	27.6	257.8	15.0	-2.4	NM	6/91
15	14	**Lotus Development Corp.**	Cambridge,Mass.	14.1	116.6	13.6	828.9	21.1	43.1	85.4	12/91
16	22	**Tandem Computers Inc.**	Cupertino,Calif.	13.9	266.6	5.1	1,922.2	3.0	35.2	-71.1	9/91
17	45	**DSC Communications Corp.**	Plano,Tex.	13.8	63.8	23.3	461.5	-11.1	-108.3	NM	12/91
18	9	**VLSI Technology Inc.**	San Jose,Calif.	13.2	54.4	1.6	413.4	27.3	9.9	NM	12/91
19	23	**Computer Associates Intl. Inc.**	Garden City,N.Y.	13.2	177.4	3.6	1,348.2	4.0	159.3	1.0	3/91
20		**SynOptics Communications Inc.**	Santa Clara,Calif.	13.1	32.4	15.4	248.3	41.1	26.8	-5.1	12/91
21		**Tektronix Inc.**	Beaverton,Ore.	12.9	172.4	-11.4	1,330.9	-5.5	48.3	NM	5/91
22	24	**Intel Corp.**	Santa Clara,Calif.	12.9	618.0	19.6	4,778.6	21.9	818.6	25.9	12/91
23	21	**Silicon Valley Group Inc.**	San Jose,Calif.	12.8	30.0	18.6	234.8	27.4	1.6	-63.1	9/91
24	12	**Microsoft Corp.**	Redmond,Wash.	12.8	235.4	30.3	1,843.4	55.8	462.7	65.7	6/91
25	44	**Autodesk Inc.**	Sausalito,Calif.	12.7	34.8	42.6	274.0	15.2	57.8	1.8	1/92
26	35	**Coherent Inc.**	Palo Alto,Calif.	12.6	26.1	19.0	207.8	8.7	0.2	NM	9/91
27	17	**Teradyne Inc.**	Boston,Mass.	12.2	62.0	-7.3	508.9	10.9	18.3	NM	12/91
28	32	**Novell Inc.**	Provo,Utah	12.2	77.9	31.4	640.1	28.7	162.5	72.3	10/91
29	42	**Sequent Computer Systems Inc.**	Beaverton,Ore.	12.1	25.8	0.0	213.3	-14.3	-48.7	NM	12/91
30	31	**Bolt Beranek and Newman Inc.**	Cambridge,Mass.	12.0	32.5	2.9	270.6	3.3	9.1	NM	6/91
31	33	**Westmark International Inc.**	Seattle,Wash.	11.9	60.1	5.4	504.7	4.1	21.4	30.5	12/91
32	37	**Silicon Graphics Inc.**	Mountain View,Calif.	11.9	65.3	43.0	549.9	31.0	32.9	2.1	6/91
33	29	**Digital Equipment Corp.**	Maynard,Mass.	11.9	1,649.4	2.2	13,911.0	7.5	-617.4	NM	6/91
34	13	**National Semiconductor Corp.**	Santa Clara,Calif.	11.7	198.6	-21.3	1,701.8	1.6	-150.3	NM	5/91
35	53	**LSI Logic Corp.**	Milpitas,Calif.	11.6	80.8	34.2	697.8	6.5	8.3	NM	12/91
36	40	**3Com Corp.**	Santa Clara,Calif.	11.4	45.4	4.0	398.6	-4.9	-27.7	NM	5/91
37	39	**Intergraph Corp.**	Huntsville,Ala.	11.2	134.4	22.1	1,195.4	14.4	71.1	13.7	12/91
38	55	**Wang Laboratories Inc.**	Lowell,Mass.	11.2	233.6	5.3	2,091.5	-16.2	-377.9	NM	6/91
39	30	**Sun Microsystems Inc.**	Mountain View,Calif.	11.1	356.6	18.1	3,221.3	30.6	190.3	71.1	6/91
40	48	**ADC Telecommunications Inc.**	Minneapolis,Minn.	11.0	32.3	26.9	293.8	13.1	22.0	-3.8	10/91
41	47	**Dynatech Corp.**	Burlington,Mass.	10.7	51.7	21.8	481.5	11.1	15.6	5.7	3/91
42	36	**Pyramid Technology Corp.**	Mountain View,Calif.	10.7	24.3	19.8	227.9	26.8	12.0	-28.5	9/91
43	49	**IBM**	Armonk,N.Y.	10.3	6,644.0	1.4	64,792.0	-6.1	-564.0	NM	12/91
44	43	**Hewlett-Packard Co.**	Palo Alto,Calif.	10.1	1,463.0	7.0	14,494.0	9.5	755.0	2.2	10/91
45	73	**Scientific Atlanta Inc.**	Atlanta,Ga.	10.0	49.2	23.8	493.7	-19.6	1.1	-97.6	6/91
46	64	**Watkins-Johnson Co.**	Palo Alto,Calif.	9.8	27.2	10.9	277.5	-11.0	-22.4	NM	12/91
47	28	**Borland International Inc.**	Scotts Valley,Calif.	9.8	22.2	54.8	226.8	100.2	26.8	127.2	3/91
48	50	**Acuson Corp.**	Mountain View,Calif.	9.7	32.7	21.8	336.3	18.9	58.5	22.3	12/91
49	46	**Beckman Instruments Inc.**	Fullerton,Calif.	9.6	82.2	2.0	857.9	5.2	38.1	5.2	12/91
50	52	**Motorola Inc.**	Schaumburg,Ill.	9.5	1,079.0	7.0	11,341.0	4.2	454.0	-9.0	12/91

NM = not meaningful

(Continued)

TOP 100 R&D SPENDERS

Rank 1991	Rank 1990	Company Location	R&D as a percentage of sales	R&D spending ($ millions)	R&D spending (% change)	1991 sales ($ millions)	% change from 1990	1991 net income ($ millions)	% change from 1990	Fiscal year
51	58	**Apple Computer Inc.** Cupertino,Calif.	9.2%	$583.0	22.0%	$6,308.8	13.5%	$309.8	-34.8%	9/91
52	67	**Measurex Corp.** Cupertino,Calif.	9.1	23.0	13.6	254.0	-4.6	0.4	-98.3	11/91
53		**Exabyte Corp.** Boulder,Co	9.0	21.1	49.2	234.1	37.5	32.2	16.7	12/91
54	59	**Fluke Mfg. Co., John** Everett,Wash.	8.8	21.1	6.4	239.7	2.5	3.2	-73.7	9/91
55	51	**Medtronic Inc.** Minneapolis,Minn.	8.8	89.5	12.8	1,021.4	22.1	133.4	22.7	4/91
56	63	**Ask Computer Systems Inc.** Mountain View,Calif.	8.7	29.9	80.8	343.9	65.8	2.7	-46.7	6/91
57	56	**AMP Inc.** Harrisburg,Pa.	8.6	265.0	0.8	3,095.0	1.7	259.7	-9.5	12/91
58	98	**Symbol Technologies Inc.** Bohemia,N.Y.	8.5	27.0	210.4	319.4	38.0	22.8	200.5	12/91
59	38	**Micron Technology Inc.** Boise,Idaho	8.4	35.8	0.4	425.4	27.6	5.1	3.5	8/91
60	65	**Western Digital Corp.** Irvine,Calif.	8.4	83.0	1.1	986.2	-7.9	-134.2	NM	6/91
61	72	**Gerber Scientific Inc.** South Windsor,Conn.	8.3	22.3	7.7	268.4	-12.6	8.0	-75.4	4/91
62	34	**Data General Corp.** Westboro,Mass.	8.3	102.0	-27.5	1,228.9	1.0	85.6	NM	9/91
63	60	**Applied Magnetics Corp** Goleta,Calif.	8.2	37.3	19.6	455.5	23.6	-18.3	NM	9/91
64		**Legent Corp.** Vienna,Virg.	8.2	16.6	16.0	203.3	19.9	33.9	3.0	9/91
65	74	**Everex Systems** Fremont,Calif.	8.1	34.2	23.5	425.1	-2.6	-48.0	NM	7/91
66	54	**Oracle Systems Corp.** Redwood Shores,Calif.	8.0	82.7	-6.3	1,027.9	5.9	-12.4	NM	5/91
67		**EMC Corp.** Hopkinton,Mass.	7.9	18.4	24.3	232.4	35.7	13.0	47.2	12/91
68	69	**Control Data Corp.** Minneapolis,Minn.	7.8	119.1	-6.3	1,524.9	-9.8	-8.6	NM	12/91
69	61	**Texas Instruments Inc.** Dallas,Tex.	7.8	527.0	-2.4	6,784.0	3.3	-409.0	NM	12/91
70	66	**Archive Corp.** Costa Mesa,Calif.	7.7	26.5	18.9	345.6	17.9	-49.3	NM	9/91
71	68	**Perkin-Elmer Corp., The** Norwalk,Conn.	7.5	65.9	4.0	874.4	4.4	-2.6	-105.8	7/91
72	57	**Storage Technology Corp.** Louisville,Colo.	7.5	118.8	20.8	1,584.9	39.0	93.1	31.8	12/91
73		**Cabletron Systems Inc.** Rochester,N.H.	7.4	13.3	72.7	180.5	72.3	35.9	60.7	2/91
74	70	**Unisys Corp.** Blue Bell,Pa.	7.3	638.9	-14.4	8,696.1	-14.0	-1,393.3	NM	12/91
75	95	**Diebold Inc.** Canton,Ohio	6.9	35.0	72.4	506.2	6.3	35.7	31.8	12/91
76	84	**Micropolis Corp.** Chatsworth,Calif.	6.9	24.1	18.3	350.9	-7.8	4.3	-45.2	12/91
77		**Komag Inc.** Milpitas,Calif.	6.5	18.0	42.8	279.2	55.2	17.2	13.4	12/91
78	75	**Xerox Corp** * Stamford,Conn.	6.4	890.0	5.0	13,819.0	1.7	436.0	-27.2	12/91
79	76	**Diasonics Inc.** Milpitas,Calif.	6.4	18.3	10.9	286.5	7.3	18.9	15.1	12/91
80		**Telxon Corp.** Akron,Ohio	6.3	11.6	12.2	184.6	28.7	12.3	NM	3/91
81	71	**Maxtor Corp.** San Jose,Calif.	6.2	54.3	52.6	871.3	77.4	-45.4	NM	3/91
82	78	**Varian Associates Inc.** Palo Alto,Calif.	6.0	83.4	7.7	1,377.9	8.9	57.5	356.4	9/91
83	85	**Compaq Computer Corp.** Houston,Tex.	6.0	197.3	6.2	3,271.4	-9.1	130.7	-71.3	12/91
84	81	**Atari Corp.** Sunnyvale,Calif.	5.9	15.3	-33.1	258.0	-37.3	23.7	NM	12/91
85	82	**Molex Inc.** Lisle,Ill.	5.7	40.7	24.2	708.0	19.1	64.6	4.1	6/91
86	89	**Augat Inc.** Mansfield,Mass.	5.7	16.0	17.6	281.6	-5.9	-22.1	NM	12/91
87	86	**GM Hughes Electronics Corp.** Detroit,Mich.	5.5	634.9	11.8	11,540.6	-1.6	381.1	-34.0	12/91
88		**Fischer & Porter Co.** Warminister,Penn.	5.4	12.8	-3.8	237.0	-0.4	-22.5	-176.5	12/91
89	88	**Conner Peripherals Inc.** San Jose,Calif.	5.3	85.0	35.2	1,599.0	19.5	92.5	-28.9	12/91
90	93	**Seagate Technology Inc.** Scotts Valley,Calif.	5.1	137.5	32.1	2,677.0	10.9	62.8	-46.4	6/91
91	83	**Loral Corp.** New York,N.Y.	5.0	105.3	50.4	2,126.8	66.9	90.4	16.5	3/91
92	80	**Quantum Corp.** Milpitas,Calif.	4.9	43.3	67.8	877.7	96.7	73.9	56.5	3/91
93	77	**Andrew Corp.** Orland Park,Ill.	4.9	20.3	-9.9	416.2	13.7	22.2	22.1	9/91
94	90	**Honeywell Inc.** Minneapolis,Minn.	4.9	300.7	7.5	6,192.9	-1.8	333.1	-10.4	12/91
95	92	**Esterline Corp.** Bellevue,Wash.	4.7	16.6	-2.3	350.9	-9.8	7.3	3.6	10/91
96	87	**Harris Corp.** Melbourne,Fla.	4.4	135.1	-7.0	3,040.1	-0.4	19.5	-85.1	6/91
97		**M/A-Com Inc.** Wakefield,Mass.	4.4	16.8	30.1	382.1	2.0	17.0	NM	9/91
98	97	**Zenith Electronics Corp.** Glenview,Ill.	4.1	54.1	-3.2	1,321.6	-6.3	-51.6	NM	12/91
99	99	**Qume Corp.** Milpitas,Calif.	4.0	8.6	4.6	217.8	-2.0	-19.6	NM	2/91
100	100	**AST Research Inc.** Irvine,Calif.	3.9	26.6	44.5	688.5	29.0	64.7	84.6	6/91

NM = not meaningful

*Data processing operations only

% change=% change from fiscal 1990

Contract manufacturing looks to higher quality, lower costs

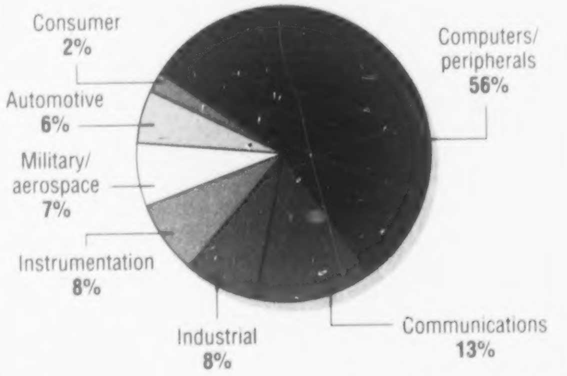
The drive to the Baldrige and ISO 9000 certification may be the engine for growing the industry by 15% this year

By Alberto Socolovsky

The next time the U.S. launches a Tomahawk cruise missile, it will be guided by circuits fabricated by a contract manufacturer. The result: a lower-cost Tomahawk that will have lost none of its deadly accuracy.

Contract manufacturing tied to computer industry

(Share of total revenue by market segments, 1991)



Source: Technology Forecasters

Farming out electronics manufacturing is a first for the Tomahawk program, although it's been done for years in the computer industry, the largest market for contract manufacturing. For military and computer OEMs, the trend is toward more contracting. Market specialist Technology Forecasters in Berkeley, Calif., puts worldwide growth of electronic contract services at 9% in 1991, for a total of $15.8 billion—$6.8 billion in North America. It expects this market to grow at least 15% in 1992.

As with the Tomahawk, contractors help OEMs achieve manufacturing quality at competitive prices. Their drive for quality was recognized last year when one of the majors, Solectron Corp. in Milpitas, Calif., won the 1991 Malcolm Baldrige National Quality Award in the "large manufacturing" category.

Quality, plus the expanding services these companies provide to OEM customers, has upgraded contract manufacturers' profile among OEMs. "We got rid of cable assemblies, sub-assembly . . . we even let our subcontractors put our box around [our computers and] ship directly to our customers," says Sun Microsystems chairman Scott McNealy, explaining the strategy that has halved manufacturing costs from the days when Sun did its own manufacturing. Sun is Solectron's major customer, followed by IBM. Both computer companies have partnering agreements with Sun that include technology sharing, early involvement in product plans, and concurrent engineering.

"Contract manufacturing" has become too restrictive a term to represent the range of services and partnerships that are becoming the norm. The Institute for Interconnecting and Packaging Electronic Circuits (IPC) in Evanston, Ill., calls them "electronic manufacturing services" (EMS) and has gathered under its wing a group of 150 such companies, including the four largest.

For the time being, the push for standards in the EMS industry comes from the European Community. Starting next year, products sold in the EC must have been assembled by plants certified as qualifying under the framework of ISO 9000, a set of guidelines for documenting quality production practices (see "Behind the facade of ISO 9000," ELECTRONIC BUSINESS, p. 40, Jan. 27, 1992). SCI Systems' plant in Huntsville, Ala., and Flextronics International's plant in Singapore have already been certified for ISO 9002, a certification level that provides a QA model for production and installation. Most EMS companies are gearing to have all their European and Southeast Asian plants certified for this standard by the end of 1992. Factories, usually at headquarters, that also provide design services must qualify for ISO 9001, a broader standard that includes QA in design and development.

Not only must plants be certified individually, notes a Flextronics source, but certification is handled by a different standards organization from each country. Thus, an OEM that wants to sell in Europe must ensure that the factory that manufactures its equipment has been certified.

The 1991 recession and the investment required in the latest assembly technologies have taken their toll on some of the smaller contractors. On the other hand, the need to put idle capacity to work has attracted the largest captive manufacturer into the EMS arena. "Thanks to our increase in [manufacturing] quality and productivity," says Pat Toole, IBM's senior vice president for manufacturing and development, "we've more capacity than we can use." Big Blue is offering printed circuit card assembly and test services at its modern Austin, Tex., plant which assembles circuit cards for its PCs and workstations.

The U.S. leaders in contract manufacturing

1991 sales ($ millions)	
SCI Systems	$1,128
Solectron	265
Avex Electronics	260
Jabil Circuit	232
Philips Circuit Assembly	150

Source: Technology Forecasters

Austin conceivably could compete with IBM's scores of EMS suppliers, from SCI Systems to such smaller players as Zercom Corp. in Merifield, Minn. Actually, each contractor brings to the party a definite skill or advantage. Philips Circuit Assemblies offers the high-speed production equipment and technology of its Dutch parent. Texas Instruments' Custom Manufacturing Services boasts quick implementation of the latest semiconductor technology.

"Contractors accounted for 37% of the U.S. purchases of production equipment for surface mounting in 1991, a tremendous jump over 1990," says electronics assembly consultant Charles-Henri Mangin of Ceeris International in Old Lyme, Conn. As for newer assembly technologies in which many EMS companies expect to lead—such as tape-automated bonding (TAB), C-IV (a high density flip-chip method developed by IBM), and multichip modules (MCMs)—Mangin cautions that these companies are still in early development. Most of the new half-million dollar production machines sold in 1991 went to captive producers, he says, including Apple, AT&T, IBM, and Sun Microsystems. ☐

Does winning a Baldrige pay off on the bottom line?

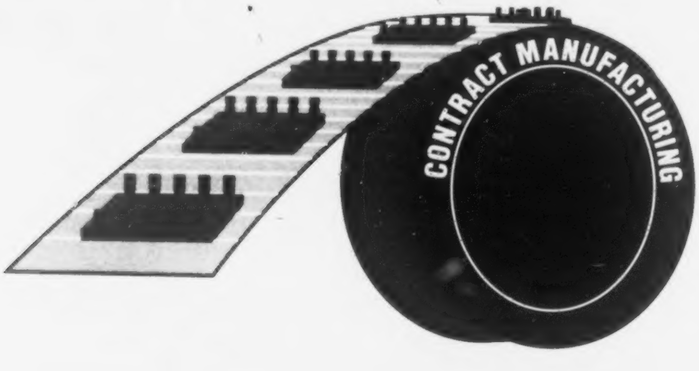
Solectron's win of the prestigious Malcolm Baldrige National Quality Award last year has not sent OEMs rushing to switch their production from in-house to a contractor, but it reinforces the feeling that contracting is the trend for the future.

"It doesn't do any harm," says Olin B. King, chairman of industry leader SCI Systems. "[The award] is important, but customers question what it means." He notes that one of the 1990 winners (Wallace Inc., a small petrochemical services company) is now in Chapter 11. SCI Systems—as well as most EMS companies, including Solectron—has concentrated on ISO 9000. "We've qualified all of our European and East Asian plants," say King. "In the long term, a contractor won't be able to compete unless he's qualified to ISO 9000."

Like many EMS companies, IEC Electronics Corp. in Newark, N.Y., follows the Baldrige criteria for quality without actually applying. "The criteria are excellent," says executive vice president Russell Stingel, "but the award has a high cost of entry." ETMA's executive vice president John Rapp explains that he had to hire two people to document the ISO process. "You need even more manpower for Baldrige."

Solectron's customers see their supplier's award as contributing to their own quality programs. At IBM, whose Rochester division itself won in 1990, director of worldwide procurement Albert Cicman says that "a key ingredient of the company's defect elimination plan is to establish and maintain a set of suppliers capable of providing parts, products, and services of the highest quality." At Exabyte in Boulder, Colo., a manufacturer of computer tape backup systems, senior vice president of operations Frank LaHue says his company's interaction with award winners is not only through Solectron, but also through Exabyte's customers Motorola (1988), Xerox (1989), and IBM (1990). "The [Baldrige] process points out areas where we can improve," says LaHue, "but the award requires more structure than we'd like." He appreciates the time that Solectron's top executives Winston Chen and Koichi Nishimura have spent addressing Exabyte's manufacturing people, but wonders about the time that executives of a winning company must spend on the road spreading the Baldrige gospel.

Nishimura defends Solectron's investment in the Baldrige. "We didn't apply to win," he explains, "but as a process to improve the company. It gave us the ability to benchmark. Baldrige helps make a better company." Still, more important than Baldrige, says Nishimura, "are the 43 customer awards we have won. They bring in the revenue." ☐



Contract manufacturing directory

Over $50 million in revenue

Avex Electronics
4807 Bradford Dr. Huntsville, AL 35805 Brian Throneberry Phone: (205) 722-6000 Fax: (205) 722-6232 Space: 574,000 a,b,c,d,e

Cerberus Pyrotronics
8 Ridgedale Ave. Cedar Knolls, NJ 07927 George Snedecor Phone: (201) 397-7272 Fax: (201) 397-7008 Space: 170,000 a,b,c,d,e Customers: Siemens, Bogen, Wells Fargo

Compas
100 Chimney Point Dr. Ogdensdurg, NY 13669 Edward Gilbert Phone: (315) 393-3573 Fax: (315) 393-7638 Space: 150,000 b,c,d,e Customers: Stratus Computer, IBM, Kodak

Comptronix
1800 Gunter Ave. Guntersville, AL 35976 Allen Shifflett Phone: (205) 582-1800 Fax: (205) 582-1817 Space: 500,000 a,b,c,d,e Customers: General Electric, NCR, Ampex, Northern Telecom

Corinth Telecommunications
Fulton Dr. Corinth, MS 38834 Bob Webb Phone: (601) 287-3771 Fax: (601) 287-1437 Space: 351,000 b,c,d,e,f Customers: IBM, Exide Elec., Gilbert Industries

CP Clare
3101 W. Pratt Ave. Chicago, IL 60645 Harsh Koppula Phone: (312) 262-7700 Fax: (312) 262-7819 Space: 120,000 b,c,d,f Customers: Texas Instruments

Dover Electronics-Eastern Div.
Kirkwood Industrial Park #5212 Binghamton, NY 13902 Robert P. Egan Phone: (607) 772-7563 Fax: (607) 772-0868 Space: 150,000 a,b,c,d,e

Type of service

a Design
b Product assembly
c Turnkey manufacturing
d Testing
e Surface mount
f Cable assembly

Dover Electronics-Western Div.
1198 Boston Ave. Longmont, CO 80501 Brent Solman Phone: (303) 772-5933 Fax: (303) 776-1883 Space: 45,000 a,b,c,d,e Customers: IBM, TRW, ISC-Bunker Ramo

Elamex
Box 10438 El Paso, TX 79995 Fred Mitchell Phone: (915) 592-1991 Fax: (915) 595-0155 Space: 800,000 b,c,d,e,f Customers: Polaroid, AT&T, Siemens

EMD Associates
4065 Theurer Blvd. Winona, MN 55987 Beth Eichman Phone: (507) 452-8932 Fax: (507) 452-5510 Space: 105,000 a,b,c,d,e

Flextronics International
48001 Fremont Blvd. Fremont, CA 94538 Sue Mucha Phone: (510) 226-3539 Fax: (510) 226-3535 Space: 300,000 a,b,c,d,e Customers: Octocom, Diebold, Logitech

GSS/Array Technology
1297 Parkmoor Ave. San Jose, CA 95126 John G. Waters Phone: (408) 999-5500 Fax: (408) 999-5565 Space: 175,000 a,b,c,d,e Customers: Maxtor, Rosemont, ICI

Group Technologies
10901 Malcolm McKinley Dr. Tampa, FL 33612 Jack Calderon Phone: (813) 972-6328 Fax: (813) 972-6715 Space: 308,000 a,b,c,d,e,f Customers: McDonnell Douglas, General Electric, Northrop

IBM/Charlotte
1001 W. Harris, #10-A/201 Charlotte, NC 28257 Phone: (704) 594-1300 Fax: (704) 594-4950 Space: 150,000 a,b,c,d,e.

IEC Electronics
105 Norton St. Newark, NY 14513 Russell E. Stingel Phone: (315) 331-7742 Fax: (315) 331-3547 Space: 300,000 b,c,d,e,f Customers: IBM, Xerox, Compaq

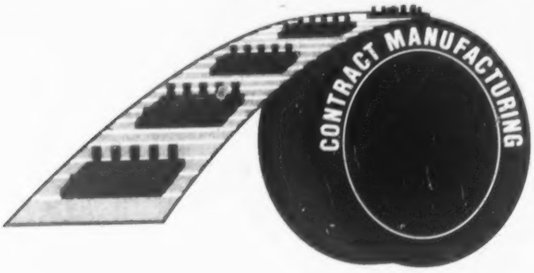
Intl. Microelectronic Products
2830 N. First St. San Jose, CA 95134 John Woodman Phone: (408) 432-9100 Fax: (408) 434-5904 Space: 81,000 a,b,c,d,e

Micron Custom Mfg. Services
8455 Westpark St. Boise, ID 83704 Steve Laney Phone: (208) 368-2600 Fax: (208) 368-2758 Space: 52,000 a,b,c,d,e Customers: IBM, Northern Telecom

PCI
1530 Parkmoor Ave. #A San Jose, CA 95128 Michael T. Clarke Phone: (408) 282-0200 Fax: (408) 282-0216 Space: 400,000 a,b,c,d,e Customers: Xerox, AT&T, Ford

Philips Circuit Assemblies
3602 W. Waters Ave. Tampa, FL 33614 Carol Maslona Phone: (813) 933-5113 Fax: (813) 933-7248 Space: 200,000 a,b,c,d,e

continued



Philips Micro Electronics
2601 South Moorland Rd. New Berlin, WI 52151 Don Weiland Phone: (414) 785-6364 Fax: (414) 785-6517 Space: 85,000 a.b.c.d.e Customers: AT&T, Hewlett-Packard, Allen Bradley

Philips Technologies-Automotive
813 S. Grandstaff Dr. Auburn, IN 46706 Harold Griswold Phone: (219) 925-8774 Fax: (219) 925-8710 Space: 100,000 b.c.d.e Customers: Harley Davidson, OMC

Plexus
55 Jewelers Park Dr. Neenah, WI 54957 Chuck Williams Phone: (414) 722-3451 Fax: (414) 722-4155 Space: 315,000 a.b.c.d.e.f Customers: IBM, General Electric

SCI Systems
13000 S. Memorial Pkwy. Huntsville, AL 35807 Michael Reale Phone: (205) 882-4400 Fax: (205) 882-4871 Space: 2,500,000 a.b.c.d.e.f Customers: IBM, Conner, Seagate

Solectron
777 Gibraltar Dr. Milpitas, CA 95035 Ed Hayes Phone: (408) 957-8500 Fax: (408) 956-6075 Space: 650,000 a.b.c.d.e Customers: Sun, IBM, Exabyte

Sparton Electronics Mfg.
30167 Powerline Rd. Brooksville, FL 34602 Alan Houghtaling Phone: (904) 799-6520 Fax: (904) 796-7482 Space: 120,000

Teledyne Lewisburg
1425 Higgs Rd. Lewisburg, TN 37091 John Murphy Phone: (615) 359-4531 Fax: (615) 359-2085 Space: 155,000 a.b.c.d.e.f Customers: Hughes, IBM, GE Westinghouse

Texas Instruments
Box 6102 Temple, TX 76503 Robert Gilbert Phone: (800) 232-3200 Fax: (817) 774-6703 Space: 4,000,000 a.b.c.d.e

Varian Tempe Electronics Center
615 S. River Dr. Tempe, AZ 85258 Ken Muller Phone: (602) 968-6790 Fax: (602) 894-5381 Space: 55,000 a.b.c.d.e

Type of service

- **a** Design
- **b** Product assembly
- **c** Turnkey manufacturing
- **d** Testing
- **e** Surface mount
- **f** Cable assembly

XETEL 8100 Cameron Rd.
Austin, TX 78753 Mark Trutna Phone: (512) 834-2266 Fax: (512) 834-9250 Space: 60,000 a.b.c.d.e Customers: Motorola, PictureTel, Kentek

$20 million to $50 million in revenue

AJ Electronics
20945 Plummer St. Chatsworth, CA 91311 Eugene Plantier Phone: (818) 998-8788 Fax: (818) 407-9440 Space: 48,000 a.b.c.d.e.f

ASD
Industry St. Poughkepsie, NY 12603 Harry J. Kane Phone: (914) 473-5530 Fax: (914) 454-2538 Space: 220,000 a.b.c.d.e.f Customers: IBM, Pitney Bowes, N.J. Turnpike Authority

Benchmark Electronics
802 West Brazospark Dr. Clute, TX Steven McGill Phone: (409) 265-0991 Fax: (409) 265-7804 Space: 65,000 a.b.c.d.e Customers: Intel, Siemens, AT&T

Electronic Fab Technology
7251 W. 4th St. Greeley, CO 80634 Wayne Cusick Phone: (303) 353-3100 Fax: (303) 893-5009 Space: 50,000 b.c.d.e.f Customers: Hewlett-Packard, Ohmeda, Colcrado Memory Systems

EOG
10947 Golden West Dr. Hunt Valley, MD 21030 Arthur Rutledge Jr. Phone: (301) 785-3000 Fax: (301) 771-5814 Space: 55,000 a.b.c.d.e

Hibbing Electronics
3125 E. 14th Ave. Hibbing, MN 55746 Michael Walsh Phone: (218) 263-8971 Fax: (218) 263-8970 Space: 86,000 a.b.c.d.e.f

Manu-Tronics
8701-100th St. Kenosha, WI 53142 Roger R. Mayer Phone: (414) 947-7700 Fax: (414) 947-7729 a.b.c.d.e.f

MEP Controls
312 Rising Sun Rd. Bordentown, NJ 08505 John Trainor Phone: (609) 298-7303 Fax: (609) 298-1982 Space: 50,000 a.b.c.d Customers: Stonite, Research Cottvell

MiNT
2650 E. Elvira Blvd. Tucson, AZ 85706 Gail Holman Phone: (602) 741-6468 Fax: (602) 741-6419 Space: 54,000 a.b.c.d.e

Pensar
2222 E. Pensar Dr. Appleton, WI 54915 Stan Plzak Phone: (414) 739-4355 Fax: (414) 739-4548 Space: 40,000 a.c.d.e

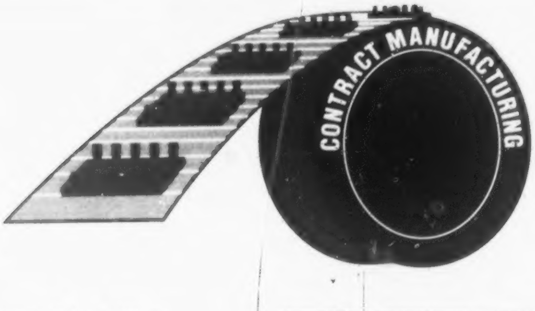
Praegitzer Industries
1270 Monmouth Cut-Off Dallas, OR 97338 Marty Filsinger Phone: (503) 623-9273 Fax: (503) 623-2303 Space: 225,000 a.b.c.d.e Customers: Protocol Systems, Intel

Senior Systems Technology
20150 Sunburst St. Chatsworth, CA 91311 Ron Viano Phone: (800) 800-0778 Fax: (818) 998-0664 Space: 54,000 a.b.c.d.e.f Customers: Xerox, IBM, Motorola

Swire Technologies
2099 Gateway Place San Jose, CA 95110 Martin Paul Phone: (408) 452-7474 Fax: (408) 452-7488 Space: 40,000 e Customers: LSI Logic, NCR Microelectronics, Motorola SPS

XCEL
4290 E. Breckell St. Ontario, CA 91761 Sam Calvillo Phone: (714) 391-4321 Fax: (714) 391-4558 Space: 100,000 a.b.c.d.e.f Customers: SCI, Allied-Bendix, Hurco, Dresser-Wayne

continued



$5 million to $20 miliion in revenue

4th Generation
4 Pheasant Run Newtown, PA 18940 Tony Tartaglia Phone: (215) 968-5700 Fax: (215) 968-6094 Space: 25,000 a,b,d,e,f Customers: IBM, General Electric, Boeing

ADCO Circuits
1900 Northfield Dr. Rochester Hills, MI 48309 Archie Damman Phone: (313) 853-6620 Fax: (313) 853-6698 Space: 23,000 a,b,c,d,e,f Customers: Ford Motor, General Dynamics

Altek
245 East Elm St. Torrington, CT 06790 Stephen Altschuler Phone: (203) 482-7626 Fax: (203) 496-7113 Space: 26,000 a,b,c,d,e,f

Altron
6700 Industry Ave. NW Anoka, MN 55303 Alan Phillips Phone: (612) 427-7735 Fax: (612) 427-3980 Space: 65,000 a,b,c,d,e,f Customers: Rosemount, Honeywell, E-Systems

Bibco
326 E. Main St. Benton Harbor, MI 49022 Phil Wilcox Phone: (616) 925-8445 Fax: (616) 925-3081 Space: 40,000 b,f Customers: Zenith, Data Systems, AT&T, ITT

CY Tech
1933 18th St. N.W. #C-1 Washington, D.C. 20009 Yogi Sood Phone: (202) 986-0200 Fax: (202) 265-7766 Space: 40,000 b,c,d,e Customers: Western Digital, Seagate Technology

CIM Systems
Lladro Bldg., Flat K 72 Hoi Yuen Rd., Kwun Tong, Kowloon, Hong Kong Peter Yim Phone: (852) 3-416-378 Fax: (852) 3-412-416 Space: 30,000 a,b,c,d,e Customers: Camintonn, Talking Technology, Dell

Type of service

- **a** Design
- **b** Product assembly
- **c** Turnkey manufacturing
- **d** Testing
- **e** Surface mount
- **f** Cable assembly

Colt Technology
15301 W. 109th St. Lenexa, KS 66219 Jeffrey S. Lynn Phone: (913) 888-1673 Fax: (913) 888-3666 Space: 170,000 a,b,c,d,e,f Customers: AT&T, Allied Signal, PPG

Continental Testing Laboratories
8385 S. Highway 17-92 Fern Park, FL 32703 R.J. Urlocker Phone: (407) 831-2700 Fax: (407) 260-2053 Space: 35,000 d Customers: General Electric, Allied Signal, McDonnell Douglas

Da-Tech
141 Railroad Dr. Ivyland, PA 18974 Bradford W. Bentz Phone: (215) 322-9410 Fax: (215) 322-9730 Space: 50,000 a,b,c,d,e Customers: Honeywell, Ametek, Brookfield Engraving

Data Signal
2403 Commerce La. Albany, GA 31708 William Sanders Phone: (912) 883-4703 Fax: (912) 884-4766 Space: 22,500 a,b,c,d,e,f Customers: Motorola, Select Manufacturing

Diagnostic Instrument
4 Copeland Dr. #J Ayer, MA 01432 James F. Hashem Phone: (508) 772-4572 Fax: (508) 772-5210 Space: 15,000 b,c,d,e Customers: Kodak, Raytheon

ETMA
15450 N.E. 95th St. Redmond, WA 98052 John Rapp Phone: (206) 885-0107 Fax: (206) 882-3516 Space: 30,000 b,c,d,e,f

Electronics Systems
Box 5013 Sioux Falls, SD 57117 Leo Reynolds Phone: (605) 338-6868 Fax: (605) 338-5061 Space: 35,000 a,b,c,d,e

continued

SURFACE MOUNT TECHNOLOGY
FOR CIRCUIT BOARD ASSEMBLY

PRODUCTIVITY

FOR TODAY

AND

TOMORROW

Electronics manufacturers are counting more and more upon their equipment vendors for **process solutions.** Count on Universal for total-process SMT systems, as well as the latest in **large-board** assembly, **10-mil fine-pitch** placement and **pick-place-attach.**

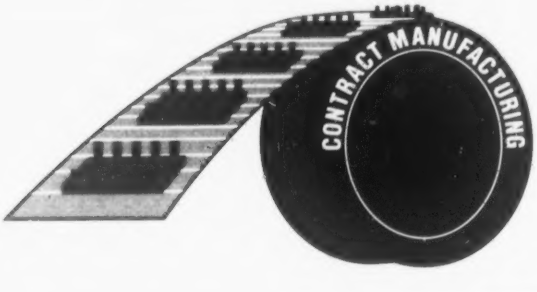
Your Universal Sales Engineer can help you develop tomorrow's process strategies, today.

Automation in electronics
Universal

Universal Instruments Corporation
P.O. Box 825, Binghamton, NY 13902
Tel: 607-779-7850 FAX: 607-772-1878

SMI SHOW #1322

PRODUCT DEVELOPMENT & MANUFACTURING



Epic Technologies
200 E. Bluegrass Dr. Norwalk, Ohio 44857 Scott Benincasa Phone: (419) 668-8117 Fax: (419) 668-2819 Space: 27,500 a,b,c,d,e Customers: Packard Electric, Bailey Controls

Express Manufacturing
3115 W. Warner Ave. Santa Ana, CA 92704 C.P. Chin Phone: (714) 556-1878 Fax: (714) 555-3199 Space: 56,000 a,b,c,d,e Customers: Xirox, Advanced Logic Research, Xircom

General Technology
6816 Washington NE Albuquerque, NM 87109 Don Dugger Phone: (505) 345-5591 Fax: (505) 344-3227 Space: 35,000 b,c,d,f Customers: McDonnell-Douglas, Bell Helicopter, Sikorsky

Kimchuk
Commerce Park, Corporate Dr. Danbury, CT 06810 Robert Glen Phone: (203) 790-7800 Fax: (203) 797-8976 Space: 100,000 a,b,c,d,e,f Customers: IBM, Stratus Computer

Micro Industries
8399 Green Meadows Dr. North Westerville, OH 43081 Bill Jackson Phone: (614) 548-7878 Fax: (614) 548-6184 Space: 40,000 a,b,c,d,e

NCR Component Evaluation
Space: Technology Center 3450 North Rock Rd. #100 Wichita, KS 67226 Richard Guy (316) 636-4800 Phone: (316) 636-4780 Space: 30,000 d,e Customers: Siemens, Honeywell, Texas Instruments

Pine Instrument
101 Industrial Dr. Grove City, PA 16127 David Savage Phone: (412) 458-6391 Fax: (412) 458-4648 a,b,c,d,f

Type of service

- **a** Design
- **b** Product assembly
- **c** Turnkey manufacturing
- **d** Testing
- **e** Surface mount
- **f** Cable assembly

Precision Graphics
59 LaGrange St. Raritan, NJ 08869 Robert Weissman Phone: (201) 707-8880 Fax: (201) 707-8884 Space: 14,500 a,b,c,d,e,f Customers: AT&T Network Systems, Ametek, Dialogic

RAMP Industries
1 North Floral Ave. Binghamton, NY 13905 Charles Faciszewski Phone: (607) 729-5256 Fax: (607) 729-2977 Space: 150,000 b,c,d,e,f

Southtronics
1265 Kennestone Cir. Marietta, GA 30066 David T. Coleman Phone: (404) 429-1000 Fax: (404) 424-2000 Space: 20,000 a,b,c,d,e

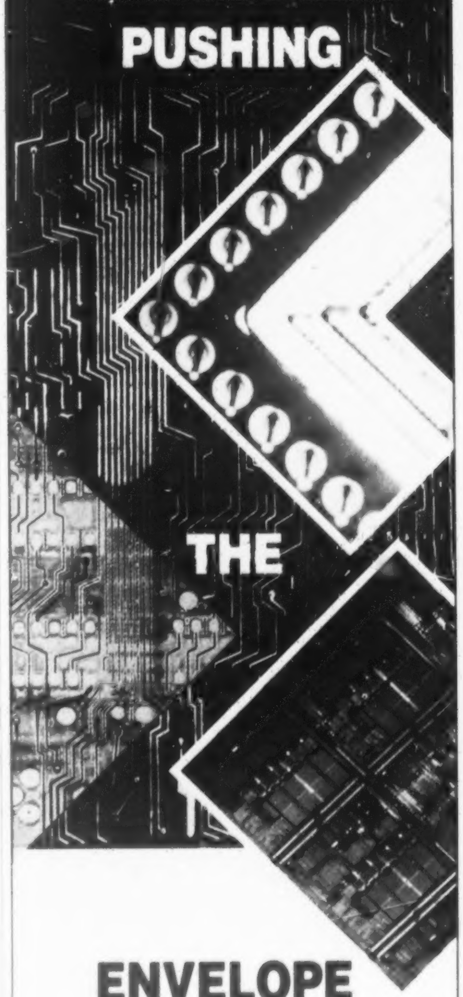
Superior Manufacturing
3133 W. Harvard St. Santa Ana, CA 92704 Jim Van Landingham Phone: (714) 540-4605 Fax: (714) 540-4542 Space: 60,000 a,b,c,d,e,f Customers: Advanced Logic Space: Research, ITT Cannon, Birtcher

Thai Micro Systems
2350 Mission College Blvd. #480 Santa Clara, CA 95054 Ernie Barrieau Phone: (408) 982-3807 Fax: (408) 988-3889 b,e

Turtle Mountain
380 Oak Grove Pkwy. St. Paul, MN 55127 Van Barkus Phone: (612) 481-1427 Fax: (612) 481-7253 Space: 52,000 b,c,d,e,f Customers: 3M, IBM, Tennant, Paramax, McDonnell Douglas

continued

ADVANCING TECHNOLOGIES FOR CIRCUIT BOARD ASSEMBLY



ENVELOPE

As **TAB flip-chips** and **multi-chip modules** redefine the ultrafine-pitch "envelope," Universal's Advanced Technology Group can help ensure that manufacturability keeps pace with design in your circuit board assembly operations. In support, our SMT Laboratory is pushing to achieve reliable, repeatable placement of **4-mil pitch devices and below.**

Contact your Universal Sales Engineer to find out more.

Automation in electronics
Universal

Universal Instruments Corporation
P.O. Box 825, Binghamton, NY 13902
Tel. 607-779-7850 FAX 607-772-1878

SMI SHOW #1322

CONTRACT MANUFACTURING

Type of service

- **a** Design
- **b** Product assembly
- **c** Turnkey manufacturing
- **d** Testing
- **e** Surface mount
- **f** Cable assembly

Vern Kiebler Electronics
201 N. Gables Blvd. Wheaton, IL 60187 Vern Kiebler Phone: (708) 668-5407 Fax: (708) 462-7590 Space: 44,000 a,b,c,d,e,f Customers: Dow Chemical, Caterpillar, Arachnid

Western Reserve Electronics
2150 Highland Rd. Twinsburg, OH 44087 Robert Rhodes Phone: (216) 425-4951 Fax: (216) 425-4956 Space: 35,000 a,b,c,d,e,f Customers: Reliance Electric, Rockwell International

Zercom Zercom Dr.
Merifield, MN 56465 Jeff Zernov Phone: (218) 765-3151 Fax: (218) 765-3900 Space: 35,000 a,b,c,d,f Customers: Westinghouse, IBM, Sony

Under $5 million in revenue

Accurate Electronics
169 S. Abbe Rd. Elyria, OH 44035 R.B. Seybold Phone: (216) 366-6330 Fax: (216) 366-0522 Space: 22,000 a,b Customers: Northrop, GE Aerospace, General Dynamics

Aerospace Industries
2101 Front St. Cuyahoga Falls, OH 44221 David M. Harry Phone: (216) 928-5002 Fax: (216) 928-5283 Space: 12,000 b,c,d,f Customers: AirCraft Braking Systems, Sechan Electronics

ARXE
1280 Piper Dr. Milpitas, CA 95035 Tom Smith Phone: (408) 945-6622 Fax: (408) 945-0373 Space: 20,000 a,b,c,d,e Customers: Logic Modeling, Space, Maxoptix, Trimble

Automation Electronics
9640 Topango Canyon Pl. #J Chatsworth, CA 91311 Robert Aiani Phone: (818) 998-5124 Fax: (818) 998-6654 Space: 12,000 b,f Customers: Hughes Aircraft, Litton Aero, Clifford

Branmag
908 Niagara Falls Blvd. North Tonawanda, NY 14120 Branko Veljkovic Phone: (716) 693-5994 Fax: (716) 856-4802 Space: 2,500 a,b,c,d,f Customers: Standard Steel, Latrobe Steel

C Enterprises
310-110 Via Vera Cruz San Marcos, CA 92069 Charles E. Blackburn Phone: (619) 744-8182 Fax: (619) 744-1659 Space: 10,000 a,b,d,f

Cable Concepts
30 Perseverance Way Hyannis, MA 02601 Ron Thompson Phone: (508) 771-7782 Fax: (508) 778-5771 Space: 3,500 a,b,c,f Customers: Boston Whaler, Fibronics, Standard Electric

CAD Engineering & Assembly
8663 Tyler Blvd. Mentor, OH 44060 Frank Novak Phone: (216) 255-7744 Fax: (216) 255-5900 Space: 7,200 a,b,c,d,f Customers: Lectranator, Whitey, Clark-Reliance

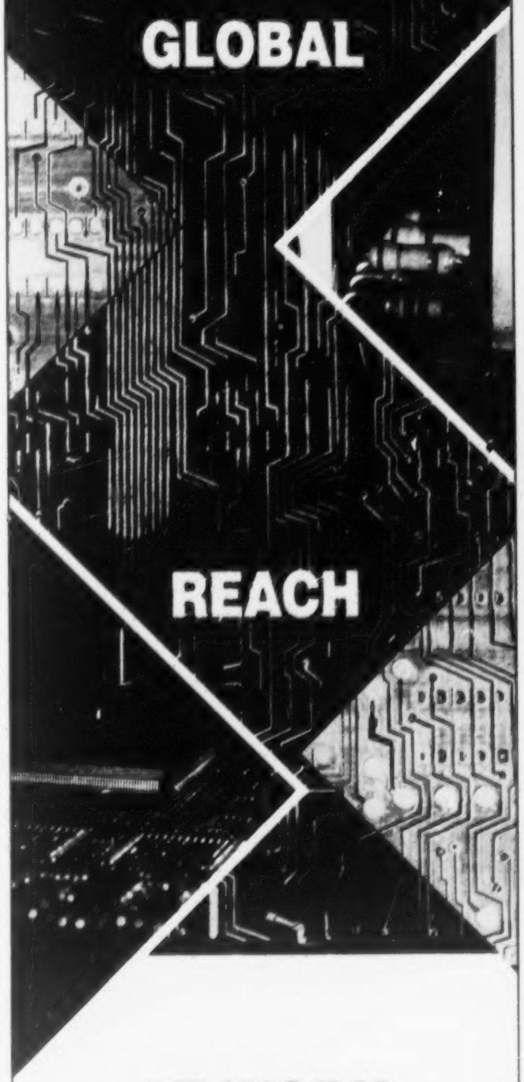
D&P Manufacturing
32 Hamilton St. Chalfont, PA 18914 Gunther Diefes Phone: (215) 997-1200 Fax: (215) 997-1200 Space: 3,000 a,b,c,d

Diversified Electronic
4969 Wakefield St. Philadelphia, PA 19144 Craig Shuman Phone: (215) 842-1144 Fax: (215) 844-4413 Space: 15,000 a,b,c,d,f

Dunham Industries
17791 Skypark Cir. #D Irvine, CA 92714 Robert Dunham Phone: (714) 261-2308 Fax: (714) 724-1610 Space: 18,000 b,c,d,e,f Customers: Symbol Technologies, Gradco, Workstation Technologies

continued

AUTOMATION IN ELECTRONICS
. . . WORLDWIDE



AT WORK

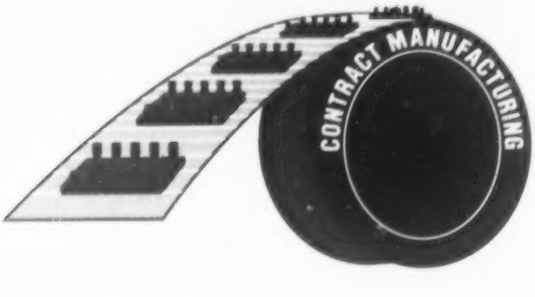
In North America, in Asia, in Europe, anywhere on the six continents where electronics manufacturing is done, Universal is there with solutions for automated circuit board assembly.
In **Thru-hole**,
in **Surface-Mount**,
in **Advancing Technologies**,
your Universal Sales Engineer can show you how to put our global reach to work for you.

SMI SHOW #1322

Contact Universal today

Automation in electronics
Universal

Universal Instruments Corporation
P.O. Box 825, Binghamton, NY 13902
Tel: 607-779-7850 FAX: 607-772-1878



ECM
1515 W. 259 St. Harbor City, CA 90710 Wes Kirchoff Phone: (213) 530-3456 Fax: (213) 530-9161 Space: 12,000 a,b,f Customers: Xerox, Karl Storz, Security Control

Electra-ssembly
Box 30 Warren, RI 02885 Richard Rosa Phone: (401) 245-5493 Space: 10,000 b,c,d,e

Electro-Support Systems
43445 Business Park Dr. #108 Temecula, CA 92590 Bob Silcott Phone: (714) 676-2751 Fax: (714) 694-0097 Space: 14,000 a,b,c,d,f Customers: Teledyne Ryan Aeronautical, Elec. Waveform GD, AIR DEF

Electronic Engineering Research
8950 Lurline Ave. Chatsworth, CA 91311 Madeline Pedego Phone: (818) 709-1195 Fax: (818) 709-1377 Space: 6,900 a,b,c,d,f Customers: Rocketdyne, JBL Professional, Aerojet Ordinance

EPS
26351 Curtiss-Wright Pkwy. Cleveland, OH 44143 Jack C. Bliss Phone: (216) 289-4115 Fax: (216) 289-4116 a,b,c,d,f

Eveready Industry
2085 Zanker Rd. San Jose, CA 95131 John Jeng Phone: (408) 943-1555 Fax: (408) 943-1248 Space: 30,000 a,b,c,d,e

Griffin
1720 J Belmont Ave. Baltimore, MD 21207 Ben Goldstein Phone: (401) 298-1710 Fax: (401) 265-8404 Space: 10,000 a,b,c,d,e,f Customers: Westinghouse, Unisys

Hutronix
2400 S. 34th Pl. Tucson, AZ 85726 Jerome Shukis Phone: (602) 790-5348 Fax: (602) 790-8836 Space: 30,000 b,c,d,f Customers: Sikorsky Aircraft, Honeywell Space

Type of service

- **a** Design
- **b** Product assembly
- **c** Turnkey manufacturing
- **d** Testing
- **e** Surface mount
- **f** Cable assembly

Manu-Tec
415 W. Belden Ave. Addison, IL 60101 Richard Zboril Phone: (708) 543-3022 Fax: (708) 543-7766 Space: 5,000 b,c,d,e,f

Micropolish
Z.I. des Pradeaux 13850 Greasque, France Gerard Gilles Phone: (33) 42-699104 Fax: (33) 42-699470 Space: 12,000 (wafer reclaim) Customers: IBM, Texas Instruments, Siemens

Mitech Electronics
411 Washington St. Otsego, MI 49078 Kendall Meyer Phone: (616) 694-9471 Fax: (616) 692-2651 Space: 40,000 a,b,c,d,f

National Telephone & Electronics
2350 NW 96th Ave. Miami, FL 33172 Joe Ardolino Phone: (305) 592-0551 Fax: (305) 599-0948 Space: 10,000 a,b,c,e,f

R&M Electronics
Box 1107 Gibsonia, PA 15044 Michael Hutchinson Phone: (412) 443-8222 Fax: (412) 444-6833 Space: 26,500 a,b,c,d,e,f

RaCoAmo
4100 Burns Rd. Palm Beach Gardens, FL 33410 Bob Hetherington Phone: (407) 626-7262 Fax: (407) 627-6753 Space: 2,500 a,b,c,d,e,f Customers: LDC Analytical, IBM

Radio Television Products
2700 N. Washington Douglas, AZ 85607 W.J. McGaw Phone: (602) 364-4438 Fax: (602) 364-4430 Space: 22,000 a,b,c,d Customers: Allied Bendix, Seiscor, Heath

SeaFab
14648 NE 95th St. Redmond, WA 98052 Bruce Murray Phone: (206) 881-2778 Fax: (206) 882-0707 Space: 11,000 a,b,c,d

Silicon Valley Turnkey
2346 Bering Dr. San Jose, CA 95731 Marlene Rozett Phone: (408) 944-9500 Fax: (408) 944-9422 Space: 5,888 a,b,c,d,e,f

System Integrators
3920 Lennane Dr. Sacramento, CA 95834 Ken McKee Phone: (916) 928-9481 Fax: (916) 928-1338 Space: 40,000 a,b,c,d,e,f

Test Group
4025 Sorrento Valley Blvd. San Diego, CA 92121 Duane Sorlie Phone: (619) 452-4160 Fax: (619) 450-9639 Space: 12,000 c,d Customers: Gould/AMI, Texas Instruments

Trionics
704 E. North St. Elburn, IL 60119 James Teppo Phone: (708) 365-6570 Fax: (708) 365-6575 Space: 18,000 a,b,c,d,e,f Customers: ITW, Eaton, Capsonic

VerTek International
9465 Custom House Plaza #D San Diego, CA 92173 John Riley Phone: (619) 661-6868 Fax: (619) 661-1229 Space: 30,000 b,d,e,f Customers: SGS Thomson, Rantec Microwave & Electronics

EDITORIAL STAFF

Publisher: Frank J. Burge
Editor: John Russell
Managing Editors: H. Garrett DeYoung, Hugh G. Willett
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, John Parker
Correspondents: Geoff Crane (Seoul), Craig Addison (Hong Kong)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Martha Abdella

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, David Webb
Sherman Building, 3031 Tisch Way, Suite 100
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ken Evans
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

VIEWPOINT

Let's rewrite the contract between business and ourselves

The recent link-up between international giants IBM, Siemens, and Toshiba to develop the next generation of memory IC's illustrates how dead the notion of an independent national corporation is becoming. Although hardly the norm—yet—this match-up demonstrates how much faster corporate structures evolve than government ones. Barring war, unforgiving market pressures are far more potent (and productive) agents of change than state powers. That, however, creates a dilemma.

On the one hand, how can a corporation—whose financial well-being doesn't necessarily imply creating jobs, technology, or wealth for a specific nation—fulfill its obligations to increase shareholders' value and, at the same time, help to improve the standard of living for those in its home country? Under current legal conditions, U.S. public companies can't, and some would argue they shouldn't.

On the other hand, how can a government—whose primary purpose is to ensure the well-being of a geographically-bound population—promote an improved standard of living for its constituents while also providing a non-intrusive environment that promotes corporate success?

The conflicts are most clear in international joint ventures. Consider the following example. When IBM and Toshiba created a jointly owned company to develop and manufacture flat panel displays, there was considerable discussion over where to build the plant. In the end, it was built in Japan. Had it been built in the U.S., the country would have gained jobs, technology transfer, and a boost to the infrastructure. Other business considerations took precedence—perhaps rightly so. IBM's goals are not necessarily those of the U.S. Toshiba's goals are certainly not. Perhaps neither's should be.

My point is this. We must find a way to redefine the relationship between business and government. Often, their goals conflict. That's not bad in itself. The problem is that industry is the real creator of wealth—not government—but industry doesn't care where that wealth is developed as long as shareholder value is increased. Government creates very little wealth, yet its job is to ensure that wealth is created among its citizens.

Somehow, we must bring these two ideas together. We must bring them together for the specific benefit of the U.S.—not just the general benefit of the international business community. It's time to rethink the social contract between businesses and their host countries. More government is not the answer. More business is.

—John Russell, editor

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc. used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.**
ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer.
Annual subscription rates for non-qualified people: USA $84.95, Mexico $124.95, Canada $133.70, other countries $149.95 per year. $140 air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

Why you can't afford to wait on CFC substitutes
PAGE 69

No end in sight for the capital-spending plunge
PAGE 81

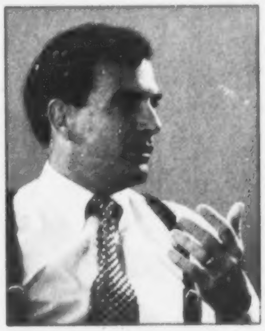
How flexible factories can pay off today *and* tomorrow
PAGE 58

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE

SEPTEMBER 1992



"The biggest problem is that we don't really have an industrial policy that we can articulate... That has to change."

J. Daniel McCranie
Chairman and CEO
Seeq Technology

ELECTION REPORT '92

THE INDUSTRY SPEAKS OUT

"I'm not sure what an industrial policy is. I'd like to see a hell of a lot less regulation."

David Bossen
President and CEO
Measurex

A roundtable of seven executives discusses what Washington must do to assist the U.S. electronics industry. Here's their prescription

PAGE 28

Electronic Business
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE
VOLUME 18, NUMBER 12
SEPTEMBER 1992

ELECTION REPORT '92 THE
INDUSTRY
SPEAKS
OUT

BUSINESS STRATEGY

28 What the next U.S. president should do for our industry
Reinvigorating the U.S. economy—and the electronics industry—is a formidable challenge awaiting our next president. ELECTRONIC BUSINESS and the American Electronics Association gathered seven leading executives to examine what the U.S. government should and shouldn't do to assist electronics companies

Business Trends

9 Industry, public agencies wrangle over radio frequencies; Did the IEEE knuckle under in reverse-engineering case?; New solutions aim to cut cost of high-speed links; How realistic are sunny PCB forecasts?

PAGE 9 Coveted bandwidth sparks communications wars

Companies to Watch

17 Modified DRAM architecture from Rambus Inc.; Avance Logic Inc. makes chipsets that focus on graphics; Automating circuit board assembly from GPAX International Inc.

PAGE 17 Rambus speeds up DRAMs by tenfold, says president Geoff Tate

Business Barometer

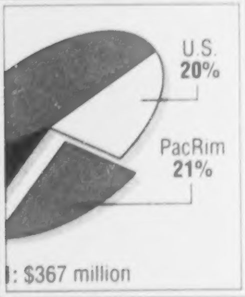
21 Computers & office equipment
Why this year's big gains are smaller than they look

21 Communication equipment
A bright 1992-93 forecast, despite some startling new data

22 Leading indicator
EBLI bounces back, but only slowly

PAGE 58 Flexible manufacturing is needed for market share, says Exabyte's Schell

PAGE 69 Electronics manufacturers begin to explore environmentally safe alternatives to ODS-based solvents



PAGE 95 Memory test market booms in the PacRim

FEATURES

BUSINESS STRATEGY

49 **Why electronics will always be Washington's stepchild**
The industry must get involved and start speaking more or less as one if it hopes to shuck its "political featherweight" image

PRODUCT DEVELOPMENT & MANUFACTURING

58 **How to make flexible manufacturing pay**
Horror stories abound of good-for-nothing robots and inefficient "factories of the future." Here's how to make sure your automation investments don't become financial debacles

69 **Time is running out for CFC users**
The ban on ozone-depleting chemicals for electronics assembly is still three years off, but dawdlers may face costly consequences

FINANCE & ECONOMICS

81 **Capital budgets shrink, but it could have been worse**
The top capital spenders cut investments by 8.8% in 1991. The outlook for 1992 isn't much better

84 **A listing of the top 100 capital spenders**
Minicomputer makers led the spending plunge last year. Software and peripherals, though, posted surprisingly aggressive figures

91 **Who's afraid of the big, bad deficit?**
The numbers are truly cosmic, but a drastic reduction could stall a shaky economic recovery

MARKETS

95 **Fragmenting memory market offers second chance to U.S. test vendors**
Japan still dominates this $300 million market, but U.S. strength in flexible testers is a better match for new market needs

DEPARTMENTS

My View *By Frank Burge, publisher*
105 Vision. And values

Company Index
106 Companies covered in this issue

Advertiser Index
109 Advertisers covered in this issue

Viewpoint *By John Russell, editor*
110 Forget dogma. Let's choose an industrial policy for the times

INTERNATIONAL

Asia's fastest-growing–and most profitable–electronics companies

Company	Growth 90/91	Company	Net income/ sales
Goldstar	23%	Nintendo	15.5%
Daewoo	20	Murata	9.7
Nintendo	19	Kyocera	6.0
Samsung Electron Devices	18	Pioneer	4.6
Samsung Electronics	16	TEL	4.2
Fujitsu	16	TDK	4.0

Source: ELECTRONIC BUSINESS

THANKS TO THE economic slump in Japan, sales by that country's largest electronics companies rose only about 5% in 1991, down from a 12% rise in 1990. That left Korean electronics makers looking especially strong: After two flat years, electronics sales by Korea's leading companies rose by 13%, to $21 billion. The top 50 electronics companies in the rest of Asia, as tracked by sister publication *Electronic Business Asia,* saw growth slip only slightly—from 19% in 1990 to 16% in 1991.

Most Asian companies' profits fell so far, however, that anyone that managed 4% margins looked good. Even at the Japanese companies that traditionally lead the industry, margins were mostly down 50% or so from 1990. Companies that fared better than average relied heavily on strong exports; Fujitsu's 17% growth, for example, came almost entirely from the computer business, and mostly from outside Japan.

a San Jose-based electronic-games maker, was sued by Japanese rival Sega for reverse-engineering a Sega Genesis video-game machine and several cartridges. A U.S. District Court in San Francisco upheld Sega's claim that Accolade illegally copied its software (see ELECTRONIC BUSINESS, August 1992, p. 9). If Sega wins the case, which could ultimately end up in the U.S. Supreme Court, the standard U.S. practice of reverse engineering may be history.

As part of the case, the IEEE filed a "friend-of-the-court" brief—only the fourth in its 108-year history—that backed Accolade's appeal by defending the concept of reverse engineering. IBM and Apple filed their own briefs defending Sega.

Shortly thereafter, attorneys for the two U.S. computer giants apparently convinced the IEEE to withdraw its support of Accolade. IEEE president Merrill Buckley, Jr. signed a three-sentence petition telling the court that its previous application to file the brief was "in error." Buckley contends that the Institute had incorrectly read its bylaws when it sanctioned the original brief.

The episode has kicked off a fire storm. "The IEEE never before allowed corporate pressure to influence its decisions," says Arv Larson, vice president of the IEEE and chairman of its U.S. Activities Board. Larson opposed the IBM and Apple attorneys at the IEEE executive committee's meeting. "The internal politics of this whole affair are disgusting," he says. "[The IBM and Apple attorneys] didn't argue the merits of the case."

Neither Larson nor Buckley will describe the specific weapon wielded by IBM and Apple; Larson says only that the decision to reverse the filing was made under "extraordinary pressure." Both companies declined comment on the incident.

The question remains: Why would IBM and Apple humiliate one of the industry's most scrupulously objective associations if not to protect themselves against the dire economic consequences of having their own products reverse-engineered?

Buckley claims to be "unhappy" about the outcome but denies that the IEEE has lost any credibility. Larson agrees that the organization's wounds aren't exactly fatal but concedes that "there are a lot of very upset members out there."

—*Willie Schatz in Washington, D.C.*

MARKETS

New solutions aim to cut cost of high-speed links

SEVERAL SUPPLIERS are addressing the growing demand for components that support transmission rates of a gigabit per second (Gbps) or more in order to reach the segment of the data communications market that isn't being served by 100-megabits-per-second (Mbps) Fiber Distributed Data Interface (FDDI). The high-speed market is being driven by applications such as scientific visualization and powerful graphics workstations.

Such high-speed links do exist, but at prohibitive costs. Developments by IBM, Hewlett-Packard, and start-up Finisar Corp., among others, should slash the cost per connection of gigabit links. In addition, evolving industry standards should provide a framework within which to apply the high-speed technologies. One key standard, Fiber Channel, is being defined under the auspices of the American National Standards Institute; another, serial High Performance Parallel Interface, is a de facto specification backed by many leading communications vendors.

HP this summer introduced a two-

CORRECTION: Electronics exports and imports for 1992 Q1 were incorrectly stated ("Selling abroad gets tougher and trade deficit gets worse," July 1992, p. 7). Exports during the quarter were in fact $18.82 billion, and imports came to $19.53 billion. The trade deficit was correctly stated at $711 million.

chip gigabit-link chipset that encodes and decodes data for transmission rates up to 1.5 Gbps. The chipset must be combined with optoelectronic transmitter and receiver components and other circuitry to build a fully functioning fiber-optic interface. Ron Whitetree, strategic marketing manager for HP's Communications Components division, tells of one HP customer who currently builds custom gigabit-rate interfaces and expects the chipset will lower the cost per connection from $25,000 to about $5,000.

The cost for gigabit interfaces could be cheaper still if the HP chips were combined with the low-cost fiber-optic transmitter and receiver modules Finisar unveiled, claims Finisar president Jerry Rawls. The company bases its components on ordinary compact-disk laser technology, which it has modified to ensure the high reliability rates that gigabit transmissions require.

IBM, meanwhile, has teamed up with HP to develop a family of products based on Fiber Channel, which designates transmission rates ranging from 133 Mbps to 1.062 Gbps. The first jointly marketed product—a $495 interconnect card for workstations and other devices—was designed and built by IBM and supports 266 Mbps rates; the partners will combine forces to create even higher-speed products.

Estimates of the size and potential of the emerging gigabit networking marketplace vary widely. This year, the market for Fiber Channel-like cards (the standard has not yet been ratified) will total just $21 million, estimates Peter Hankin, a partner with research firm Ryan, Hankin, Kent Inc. By 1995, he expects the market to grow to only $65 million. Industry participates say that estimate is far to conservative, even given that the Fiber Channel sector represents just one of several gigabit networking niches. "Everybody wants to go to higher data rates," says Bill Craven, vice president and general manager of the Components Group at HP. "The [overall] market may be many hundreds of millions [of dollars] in three to five years."

—*D.D.*

MARKETS

How realistic are sunny PCB forecasts?

EVEN IF it's a case of too little, too late, printed circuit board (PCB) manufacturers aren't complaining about their industry's outlook.

Thanks to a rebound in computer and communications end-markets, the $4.8 billion U.S. rigid PCB market is poised to expand shipments by 7.6% this year and 12% next year, say forecasters Ed Henderson and William Loeb. Laminates—the products that go into PCBs—will enjoy 8.7% and 15.3% growth this year and next, with help from 9% to 15% increases in prices due to a reduced supplier base, says Henderson. Fellow forecaster John DeWolf predicts PCB shipments—which include the $370 million flexible circuit market—will rebound from a 1.7% drop last year to 14.3% growth this year, and surge 26.6% in 1993.

Their optimism stems from several trends. First, outsourcing to independent assemblers is growing among OEMs, and the assemblers are looking to outsource their PCBs. "The two trends are inescapable," says Tony Hilvers of the Institute for Interconnecting and Packaging Electronic Circuits. According to Hilvers, last year 66% of OEMs decided to buy, rather them make, PCBs—up from 53% in 1981.

Other factors are more speculative. The marriage of computers and communication technology should surge end-market demand. Consumer electronics manufacturing is expected to come back on shore. And, after a decade of deterioration (see table), PCB makers are hopeful that manufacturing will return to U.S. sites due to a more competitive cost structure as plants become less labor-intensive and more automated.

So far, in the first six months of the year, rigid PCB sales have risen a modest 5%. Phil Lapin of Electronic Market Consulting predicted last December that U.S. producers of PCBs would see only 5% growth in 1992 and 1993. "I'll stand by that forecast till you blow me off the podium," he says. The trend to offshore PCB manufacturing will continue, Lapin believes, especially as the OEM captive producers sell off their PCB divisions and start sourcing worldwide. With more than 1,000 printed circuit board makers four years ago and under 750 now, Lapin expects consolidation to continue. "There's simply no reason for many of them to stay in business," warns Lapin.

—*E. B. Baatz*

MARKETS

A historical look at world market share for printed circuit boards

	World market	U.S.	Japan	Europe	Rest of world
	($ millions)	(% market share)			
1980 (226Y=$1)	$6,465	40.2%	19.6%	20.3%	19.9%
1988 (125Y=$1)	19,949	29.5	29.2	15.1	26.2
1991 (126Y=$1)	18,974	26.9	34.4	16.0	22.7
1991 (226Y=$1)	$16,126	32.0	23.0	19.0	26.0

Source: IPC

This table shows world market shares for 1980, 1988, and 1991. However, some of the U.S.'s market share decline was due simply to currency fluctuations. The bottom line of the table shows what world market shares would have been in 1991 if the value of the yen had remained at its 1980 level.

COMPUTERS AND OFFICE EQUIPMENT

Why this year's big gains are smaller than they look

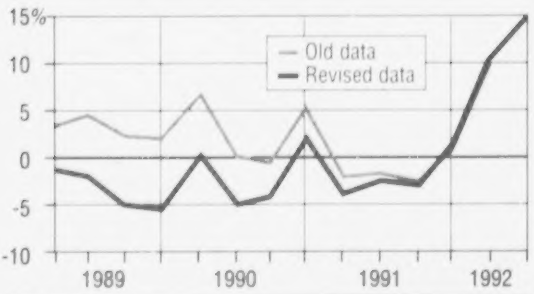
Computer and office equipment shipments advanced to $17.8 billion in the second quarter of 1992, up 3.9% from the first quarter and 14.7% from a year ago. As a result, Cahners Economics has revised its shipments forecasts upward to 11.4% growth in both 1992 and 1993. But at least a portion of those strong gains is a mirage: The 1991 computer industry recession was much worse than originally thought, according to the latest annual statistical revisions from the U.S. Commerce Department, so much of the big gain was spent just in climbing out of the hole.

Previously, statistics on computer and office equipment shipments showed year-ago losses in four of the five quarters from third-quarter 1990 through third-quarter 1991. Now, the numbers show the industry suffered through nine quarters of year-ago declines starting as early as the first quarter of 1989. So, what number-watchers first viewed as a shorter and milder recession relative to the 1986 downturn was, in fact, longer and deeper.

What's past is past, but one sad fact remains: Industry shipments in the second quarter of this year are only $475 million more than the last three-month high recorded back in the third quarter of 1988. Executives, busy fighting massive price wars, are not surprised at what the government numbers are finally revealing. Without stronger GDP growth, a full recovery from such a rough computer recession won't be easy.

—Madeline Franchi

Shipments (% change from prior year)



($ billions)					FORECAST			
Orders	15.1	16.0	16.5	17.3	**17.3**	**17.7**	**19.3**	**19.7**
Shipments	15.3	16.4	17.2	17.8	**17.4**	**17.6**	**18.9**	**19.4**
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
	1991		1992				1993	

Source: Commerce Dept.; Forecast: Cahners Economics

COMMUNICATION EQUIPMENT

A bright 1992-93 forecast, despite some startling new data

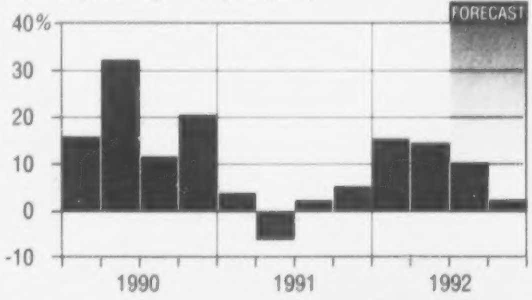
Cahners Economics forecasts communication equipment shipments will advance 6.7% in 1992 and 8% in 1993, which is not much changed from the predictions published last quarter. Second-quarter shipments jumped 8.1% from a year earlier, keeping the rebound on course. Like the computer industry, startling revisions to the historical data by the Commerce Department have painted quite a different picture of the past few years.

The so-called recession-proof communications equipment industry originally reported shipments growth of 18.6% in 1989. Commerce's revisions now show the industry stumbled with a 2.5% decline in shipments instead. According to Commerce, this change stemmed from reporting problems and were related to revisions based on the new Standard Industrial Classification codes instituted about two years ago.

Still, the future looks bright. Orders for communication equipment have posted strong year-ago leaps. The increases have pushed the book-to-bill ratio above 1.00 in three of the past four months, adding to the already healthy backlogs. These demand-side numbers reinforce our confidence in the shipments forecasts.

—M.F.

Orders (% change from prior year)



($ billions)					FORECAST			
Orders	9.7	10.7	10.9	10.8	**10.7**	**10.9**	**11.3**	**11.8**
Shipments	10.4	10.7	10.9	10.9	**11.0**	**11.2**	**11.5**	**11.7**
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
	1991		1992				1993	

Source: Commerce Dept.; Forecast: Cahners Economics

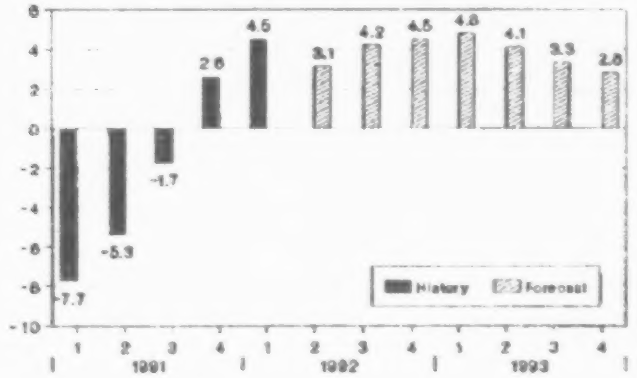
Due to editing errors, incorrect data were printed in the July 1992 business barometer column (p. 19). To receive a corrected copy of the table and charts, please contact Jean O'Brien at (617) 558-4257, or fax (617) 558-4327.

CORRECTION

Corrections to charts and data for ELECTRONIC BUSINESS, July 1992, page 19, business barometer column

Measuring & Controlling Shipments

(% change from prior year)



Data: U.S. Commerce Department;
Forecast: Cahners Economics

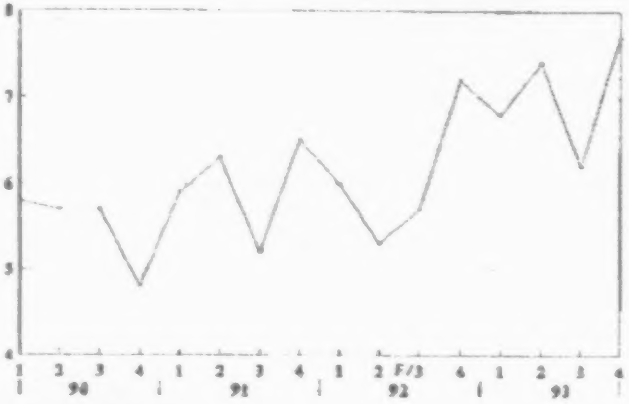
($ billions)

	1991			1992				1993
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Orders	6.87	6.62	7.24	6.88	7.02	7.15	7.45	7.19
Shipments	6.97	6.90	7.17	7.16	7.18	7.19	7.49	7.60

Forecast.........

Electronic Component Leadtimes

Delivery time in weeks



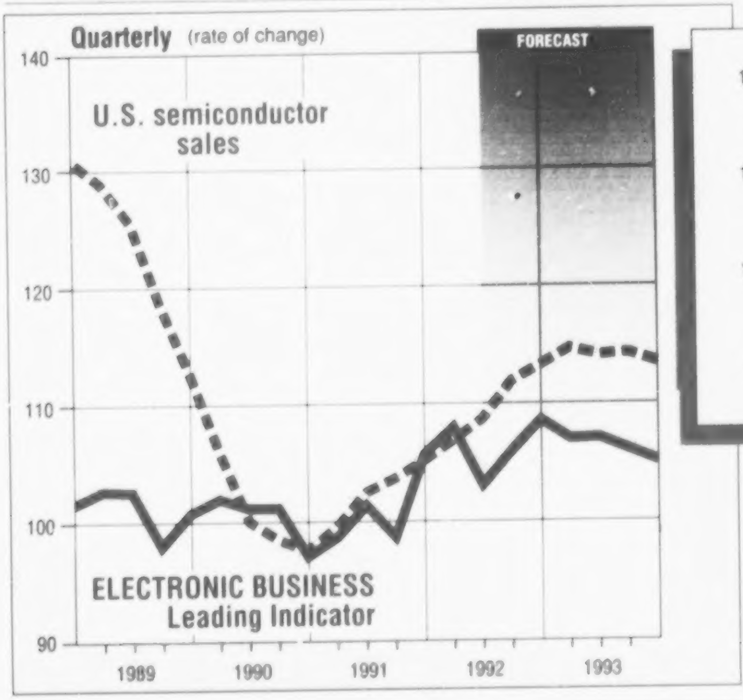
Source: Electronics Purchasing
Forecast: Cahners Economics

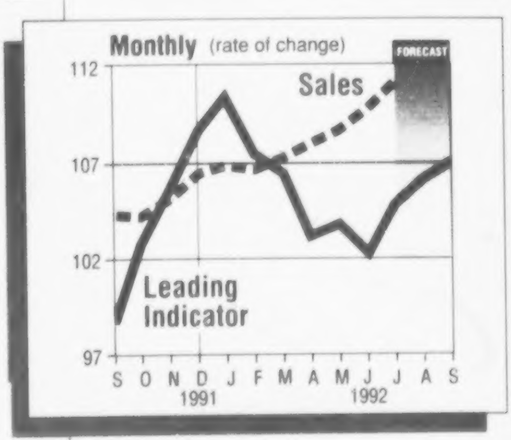
($ billions)

	1991			1992				1993
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Orders	15.6	15.7	16.9	15.8	16.7	17.3	19.0	18.0
Shipments	15.9	15.9	16.3	16.1	17.1	17.4	18.1	18.0

Forecast.............

ELECTRONIC BUSINESS Leading Indicator



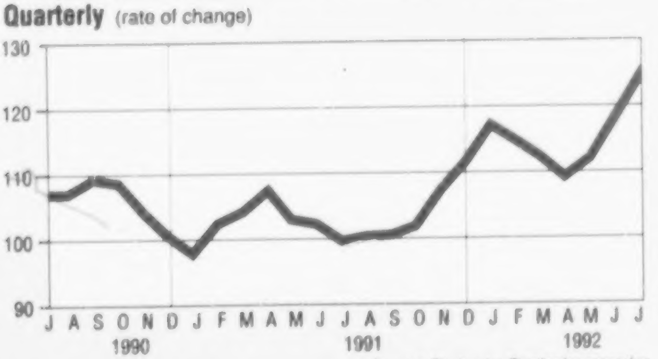


EBLI bounces back, but only slowly

Thankfully, the Electronic Business Leading Indicator (EBLI) jumped to 104.8 in July, which helps to quell fears of a triple-dip industry recession anytime this year. Since its last peak of 110.3 in January 1992, the EBLI had skidded to only 102.3 this past June. Last year, the EBLI began the perennial summer slump with a mark of 98.9 in July—truly cause for concern. This year, it averaged 105.5 during the first seven months and is expected to accelerate through the end of 1992 to a peak of 109.4 in December.

—*John Farrell*

Growth in chip bookings continue to surge



Source: *Electronics Purchasing* magazine

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, July)	104.8	102.3	98.9	101.1
U.S. semiconductor bookings ($ millions, 3-month average, July)	$1.599	$1,677	$1,241	$1,311
Weekly hours of semiconductor production workers (monthly average, June)	41.7	42.3	40.8	41.1
Electronic components lead time index (1977 = 100, Aug.)	92.5	102.6	75.3	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, July)	84.3	79.9	68.3	68.5
Change in electronic components inventories ($ millions, SA, June)	$39	-$80	-$46	-$57
Contracts and orders for plant and equipment ($ billions, SA, June)	$34.7	$33.4	$30.7	$33.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100. For more information about Cahners Economics, call Dan Buchan at (617) 630-2105.

TOP 100
CAPITAL
SPENDERS

Capital budgets shrink, but it could have been worse

The top 100 capital spenders cut investments by 8.8% in 1991. The outlook for 1992 isn't much better

By E. B. Baatz

It's time to face the music, and it sounds more like a dirge than a ditty for capital spending in the electronics industry. After a stately 7.2% gain in capital spending by the industry's top 100 spenders in fiscal 1990, investments in new plant and equipment sagged 8.8% last year. Excluding IBM, which accounts for 35% of the group's total spending, capital investment fell 13%. After adjusting for inflation, the investment record lately looks even gloomier. With only $18.5 billion spent by the 100 most capital-intensive companies last year, spending has retreated to 1988 levels.

The future doesn't hold much promise for a rapid rebound either. With a lagged response to last year's red ink, capital budgets for the top 100 spenders are likely to drop another 5%. That's reminiscent of the 1985-86 recession, when capital spending by the 100 fell during its two-year slump by 8% and 13%. In fact, the ELECTRONIC BUSINESS summer 1992 CFO survey confirms that slow sales and profits growth is continuing to cut into corporate capital budgets. Surprisingly, however, cutting costs have not been the electronics CFOs number-one goal (see sidebar).

Still, the capital-budget cuts could have been—some may say *should* have been—much worse. After all, 1991 was the year that the top 200 electronics companies in the U.S. suffered a 54% plunge in profits—the single worst decline on record. Not unexpectedly, the culprits were the big guys that were so busy restructuring their businesses and recalculating their balance sheets. The six companies in the "diversified electronics" category—IBM, Hewlett-Packard, Honeywell, Harris, Varian, and Mark IV Industries—accounted for more than 42% of all the capital investments made by the top 100 spenders. While the group is dominated by Big Blue's capital

Results of the summer 1992 CFO survey

CFOs say slow sales growth still constrain capital budgets

Slow growth in sales and profits continues to plague electronics companies' capital budgets this summer. So say 122 chief financial officers (CFOs) surveyed in ELECTRONIC BUSINESS's semiannual capital spending poll. In fact, 63% of the CFOs say slow sales and profits remain the biggest constraint to their capital spending plans, nearly unchanged from the 60% who rated that as a factor in a poll conducted six months earlier.

Finance officers have barely altered their spending budgets since last winter. Forty-four percent now plan to increase their capital budgets from fiscal 1991 to 1992, compared with 42% last winter.

Looking ahead to next year, 47% of the CFOs surveyed expect to increase budgets from current levels. Another 15% expect budgets to fall, and the remainder say their company's capital spending will be flat. As a share of revenue, the finance officers indicate capital spending stood at an average 10.3% in 1991, has fallen to 7.7% in 1992, will drop again to 7.3% in 1993, and will remain at 7.3% in 1996.

In an examination of near-term management action items, ELECTRONIC BUSINESS found that CFOs and CEOs appear to be in sync for the most part. Both the CFOs surveyed this summer and CEOs surveyed last fall in the ELECTRONIC BUSINESS/Ernst & Young CEO survey rated "measure customer satisfaction" and "improve commitment to quality" as the two most important management goals. They differed, however, on the third most-important action: CEOs focus on decreasing product cycle times while CFOs are more concerned about reducing current costs.

For complete results of the summer 1992 CFO survey, or to join our financial advisory panel, write ELECTRONIC BUSINESS, 275 Washington St., Newton, MA 02158; Attn: E. Baatz. Fax: (617) 558-4327 ☐

Most industry segments pulled back on capital spending last year

		Capital spending in fiscal 1991		
Industry (# of companies)	**% of top 100**	**$ millions**	**% change from 1990**	**% of 1991 revenue**
Diversified (6)	42.2%	$7,812	-2.2%	8.6%
Semiconductors (11)	10.8	1,998	-15.6	11.5
Communications (11)	8.2	1,514	1.4	10.1
Government (7)	7.8	1,451	-10.2	4.7
Minicomputers (5)	6.0	1,120	-29.7	5.7
Desktop computers (7)	4.2	781	-12.3	4.9
Office equipment (3)	4.2	771	-4.0	3.6
Mainframes (7)	4.0	733	-24.7	5.4
Software (10)	3.2	585	35.9	8.2
Components (9)	3.2	583	7.2	9.5
Peripherals (9)	3.0	544	15.7	5.8
Medical electronics (4)	0.9	171	8.0	6.3
Instruments (4)	0.7	122	-17.0	4.1

The data above excludes seven companies in miscellaneous industry segments

Source: ELECTRONIC BUSINESS

budget, only one company in this segment—Varian—spent more on plant and equipment in 1991 than in 1990. Altogether, the six diversified electronics companies cut capital spending 2%.

Capital budgets for other industry segments were battered even worse than the diversified group. Bombarded by vast changes in their markets and competition from high-powered desktop computer makers, for example, the five minicomputer makers collectively cut their capital budgets by 29.7% last year. Tandem and Digital Equipment led the way by slashing their budgets 54% and 28%, respectively. Unfortunately, those cuts were more than simply a response to falling sales: Capital spending was cut much faster than the decline in revenue. The weighted average of the minicomputer group's capital-spending-to-sales ratio fell from a stellar 8.4% in 1990 to only 5.7% last year.

The ratio of capital spending to revenue is an important one, since mature companies and industries should be spending more relative to revenue today than five years ago. Why? Today's shorter product cycles means stepped-up spending for tooling, explains Benjamin Savidge, chief financial officer for component maker Amp Inc. in Harrisburg, Pa.

Other industries that may be mortgaging their future by cutting capital spending too fast include semiconductors and mainframe computers. Both plundered their capital budgets, by 16% and 25%, respectively.

Mortgaging their futures? Semiconductor, mainframe, and minicomputer makers plundered their capital budgets last year

For the 11 chip companies that make up the semiconductor group, though, a fall in the capital-spending-to-sales ratio from 15.1% in 1990 to 11.5% in 1991 may not be as worrisome as it appears at first glance. The decline was due mostly to Advanced Micro Devices' planned cutback in plant and equipment spending as it wound up development costs for its 386 chip clone and completed its submicron development center.

AMD's 64% cut in capital spending from 1990 to 1991 was surpassed only by an unexpected 67% capital budget cut by a beleaguered DSC Communications. While DSC saw the largest capital spending declines among the 100, many others took big hits, too. Texas Instruments, Unisys, Compaq Computer, and SCI Systems all scrambled to stem last year's overwhelming flow of red ink.

Spending within the U.S. chip industry was led by Intel, which fell only $52 million short of an even $1 billion on capital investments last year. Showing no signs of letting up, the company plans to top $1 billion in capital spending this year.

Some entire industry segments managed to raise capital spending significantly. The best industry for that was software. While those companies aren't typically thought of as big spenders, their total plant and equipment budgets surged 36% from 1990 to 1991, and they spent $585 million last year—more than either the components or the peripherals segments.

The software industry grew plant and equipment spending so rapidly thanks to an acquisition-driven 900%-plus jump in spending by Borland International and another acquisition-driven 209% spending rise by Novell. A 67% increase in capital spending by Microsoft, the software segment's biggest spender, also helped.

Other segments that invested more in plant and equipment in 1991 than in 1990 were peripherals (up 16%), medical electronics (8%), and components (7%). Communications equipment makers also defied the recession by growing capital spending 1.4% to a collective $1.5 billion in fiscal 1991.

Perhaps the most encouraging sign for U.S. electronics makers, albeit not necessarily for U.S. electronics workers, is that companies that are driving hard to tap into markets abroad have been investing more and more in new plants regardless of the recession. For example, both Read-Rite and Dell Computer grew their capital budgets by 535% and 244%, respectively. Thin-film component maker Read-Rite has been busy constructing and equipping a new plant in Thailand, while Dell's entree into Europe meant building a new 136,000-square-foot facility in Limerick, Ireland. ◆

TOP 100 CAPITAL SPENDERS

Company (location)	Capital spending ($ millions)	Rank	1991/1990 change (%)	Rank	Spending/ sales (ratio)	Rank	Spending/net cash flow* (ratio)	Rank	Fiscal year ended
IBM Armonk,N.Y.	$6,497.0	1	-0.2%	48	10.0%	17	188.6%	8	12/91
Motorola Schaumburg,Ill.	1,317.0	2	4.9	41	11.6	13	106.2	17	12/91
Intel Santa Clara,Calif.	948.3	3	39.5	19	19.8	3	76.7	33	12/91
Hewlett-Packard Palo Alto,Calif.	862.0	4	-9.7	61	5.9	51	68.5	37	10/91
Digital Equipment Maynard,Mass.	737.5	5	-28.2	82	5.3	62	349.3	4	6/91
GM Hughes Electronics Detroit,Mich.	681.3	6	-23.0	77	5.9	54	114.7	16	12/91
Texas Instruments Dallas,Tex.	504.0	7	-44.6	95	7.4	36	553.8	1	12/91
Xerox Stamford,Conn.	498.0	8	12.2	36	2.8	90	63.8	41	12/91
Raytheon Lexington,Mass.	348.5	9	-10.8	64	3.8	81	54.9	52	12/91
Amdahl Sunnyvale,Calif.	327.9	10	7.9	39	19.3	5	225.7	7	12/91
AMP Harrisburg,Pa.	313.3	11	-7.4	59	10.1	16	86.4	24	12/91
Microsoft Redmond,Wash.	264.4	12	67.2	13	14.3	8	49.1	60	6/91
Litton Industries Beverly Hills,Calif.	255.1	13	33.5	24	4.9	66	90.0	20	7/91
Pitney Bowes Stamford,Conn.	250.4	14	-22.4	76	7.5	35	59.9	47	12/91
Unisys Blue Bell,Pa.	248.3	15	-46.0	96	2.9	89	-34.5	91	12/91
Honeywell Minneapolis,Minn.	240.2	16	-4.5	55	3.9	79	78.5	32	12/91
Apple Computer Cupertino,Calif.	218.3	17	-2.7	52	3.5	84	47.7	62	9/91
Sun Microsystems Mountain View	192.3	18	-9.7	60	6.0	50	46.7	63	6/91
Compaq Computer Houston,Tex.	188.7	19	-41.9	92	5.8	55	63.7	42	12/91
Tandy Ft. Worth,Tex.	139.5	20	23.9	26	3.1	87	54.8	53	6/91
Tandem Computers Cupertino,Calif.	138.4	21	-54.1	98	7.2	38	70.0	36	9/91
Harris Melbourne,Fla.	133.5	22	-30.9	85	4.4	72	81.9	29	6/91
Wang Laboratories Lowell,Mass.	129.7	23	-15.1	72	6.2	47	-77.2	95	6/91
Advanced Micro Devices Sunnyvale	111.0	24	-63.5	99	9.1	20	38.2	74	12/91
Storage Technology Louisville,Colo.	110.7	25	86.4	9	7.0	40	54.0	55	12/91
National Semiconductor Santa Clara	109.8	26	-39.7	91	6.5	45	508.3	3	5/91
Molex Lisle,Ill.	109.2	27	50.2	17	15.4	7	89.3	21	6/91
Loral New York,N.Y.	93.1	28	52.0	16	4.4	73	55.3	51	3/91
Intergraph Huntsville,Ala.	91.6	29	15.0	32	7.7	33	65.8	38	12/91
Seagate Technology Scotts Valley,Calif.	90.9	30	-11.2	66	3.4	85	39.9	73	6/91
Conner Peripherals San Jose,Calif.	87.7	31	-7.4	58	5.5	57	61.5	45	12/91
Novell Provo,Utah	86.9	32	209.0	4	13.6	9	46.5	64	10/91
Data General Westboro,Mass.	82.8	33	-2.7	53	6.7	42	43.2	67	9/91
Western Digital Irvine,Calif.	76.9	34	-11.0	65	7.8	31	-95.7	96	6/91
LSI Logic Milpitas,Calif.	73.7	35	18.8	30	10.6	15	80.7	30	12/91
Tektronix Beaverton,Ore.	67.9	36	-30.0	84	5.1	64	64.4	39	5/91
Beckman Instruments Fullerton,Calif.	67.5	37	0.3	47	7.9	28	78.6	31	12/91
Applied Materials Santa Clara,Calif.	67.5	38	-39.2	90	8.0	25	133.1	11	10/91
Medtronic Minneapolis,Minn.	65.8	39	19.1	29	6.4	46	36.6	76	4/91
Cypress Semiconductor San Jose,Calif.	64.8	40	77.1	11	22.6	1	85.6	26	12/91
Oracle Systems Redwood Shores,Calif.	60.7	41	-32.0	86	5.9	53	104.1	18	5/91
Varian Associates Palo Alto,Calif.	59.7	42	8.6	38	4.3	74	63.9	40	9/91
Komag Milpitas,Calif.	54.4	43	20.4	28	19.5	4	121.4	12	12/91
Analog Devices Norwood,Mass.	52.3	44	36.8	20	9.7	18	85.8	25	10/91
E-Systems Dallas,Tex.	52.1	45	-13.4	69	2.6	93	38.1	75	12/91
Micron Technology Boise,Idaho	52.0	46	-34.9	87	12.2	12	54.5	54	8/91
Silicon Graphics Mountain View,Calif.	47.2	47	59.5	15	8.6	21	74.8	35	6/91
Cray Research Eagan,Minn.	46.7	48	-25.5	79	5.4	58	14.7	86	12/91
Maxtor San Jose,Calif.	46.3	49	3.6	42	5.3	61	320.1	5	3/91
Quantum Milpitas,Calif.	46.0	50	175.8	5	5.2	63	53.4	57	3/91

(continued)

FINANCE & ECONOMICS

TOP 100 CAPITAL SPENDERS

Company Location	Capital spending ($ millions)	Rank	1991/1990 change (%)	Rank	Spending/ sales (ratio)	Rank	Spending/net cash flow* (ratio)	Rank	Fiscal year ended
Lotus Development Cambridge,Mass.	$38.8	51	-24.8%	78	4.7%	69	34.1%	80	12/91
Zenith Electronics Glenview,Ill.	36.7	52	13.3	34	2.8	91	-267.9	99	12/91
Applied Magnetics Goleta,Calif.	35.7	53	-10.6	63	7.8	29	317.8	6	9/91
Read-Rite Milpitas,Calif.	35.6	54	535.3	2	20.1	2	120.1	13	9/91
Integrated Device Tech. Santa Clara	35.6	55	1.6	45	17.9	6	117.6	15	3/91
Control Data Minneapolis,Minn.	32.9	56	-14.8	71	2.2	95	35.6	78	12/91
VLSI Technology San Jose,Calif.	32.8	57	-7.0	57	7.9	27	56.3	49	12/91
Dell Computer Austin,Tex.	32.6	58	244.0	3	3.7	82	50.4	58	1/92
Stratus Computer Marlborough,Mass.	31.5	59	14.9	33	7.0	39	35.1	79	12/91
Mentor Graphics Wilsonville,Ore.	31.2	60	-10.4	62	7.8	30	-73.9	94	12/91
SCI Systems Huntsville,Ala.	30.3	61	-51.6	97	2.7	92	75.1	34	6/91
Cadence Design Systems San Jose	29.6	62	33.6	23	7.6	34	185.0	9	12/91
Perkin-Elmer Norwalk,Conn.	29.3	63	103.5	7	3.3	86	519.5	2	7/91
Borland Intl. Scotts Valley, Calif.	28.2	64	902.8	1	12.4	10	85.1	27	3/91
Vishay Intertechnology Malvern,Pa.	26.7	65	-13.7	70	6.0	48	55.6	50	12/91
3Com Santa Clara,Calif.	26.6	66	3.2	44	6.7	43	-532.4	100	5/91
Sequent Computer Beaverton, Ore.	26.3	67	-44.5	94	12.3	11	-127.7	98	12/91
Pyramid Technology Mountain View	26.1	68	1.4	46	11.5	14	83.6	28	9/91
Andrew Orland Park,Ill.	25.0	69	-0.6	49	6.0	49	58.9	48	9/90
ADC Telecom Minneapolis, Minn.	24.6	70	78.9	10	8.4	24	61.4	46	10/91
Teradata El Segundo,Calif.	24.4	71	-29.0	83	9.5	19	98.7	19	6/91
Westmark Seattle,Wash.	24.0	72	25.3	25	4.7	68	61.7	44	12/91
Sprague Technologies Stamford,Conn.	22.7	73	48.4	18	7.7	32	-63.1	93	12/91
Savin Stamford,Conn.	22.5	74	-38.1	88	7.2	37	-32.2	90	12/91
DSC Communications Plano,Tex.	22.3	75	-67.2	100	4.8	67	-56.8	92	12/91
SynOptics Communications Santa Clara	20.9	76	-1.4	50	8.4	23	53.7	56	12/91
Avnet Great Neck,N.Y.	20.4	77	17.2	31	1.2	100	31.4	81	6/91
Scientific Atlanta Atlanta,Ga.	19.9	78	-27.2	81	4.0	77	139.6	10	6/91
Mark IV Industries Amherst,N.Y.	19.8	79	-5.3	56	2.1	96	41.0	71	2/91
EMC Hopkinton,Mass.	19.7	80	21.1	27	8.5	22	88.1	23	12/91
Computer Associates Garden City,N.Y.	19.2	81	-15.8	73	1.4	99	7.5	87	3/91
M/A-Com Wakefield,Mass.	17.2	82	-1.9	51	4.5	71	41.5	70	9/91
Symbol Technologies Bohemia,N.Y.	17.2	83	12.6	35	5.4	59	48.8	61	12/91
Dynatech Burlington,Mass.	16.8	84	11.8	37	3.5	83	43.7	66	3/91
Micropolis Chatsworth,Calif.	16.4	85	88.2	8	4.7	70	63.2	43	12/91
CTS Elkhart,Ind.	16.0	86	35.1	21	7.0	41	118.5	14	12/91
Teradyne Boston,Mass.	14.6	87	-39.1	89	2.9	88	26.5	83	12/91
Cabletron Systems Rochester,N.H.	14.5	88	34.9	22	8.0	26	36.5	77	2/91
Augat Mansfield,Mass.	14.2	89	-20.4	75	5.1	65	-107.2	97	12/91
Sensormatic Deerfield Beach,Fla.	14.2	90	76.4	12	5.9	52	46.3	65	5/91
International Rectifier El Segundo,Calif.	14.2	91	155.8	6	5.6	56	49.1	59	6/91
Acuson Mountain View,Calif.	13.8	92	-17.2	74	4.1	76	20.1	85	12/91
Legent Vienna,Va.	13.6	93	3.5	43	6.7	44	28.9	82	9/91
Adobe Systems Mountain View,Calif.	12.2	94	65.0	14	5.3	60	20.2	84	11/91
Bolt Beranek and Newman Cambridge	10.8	95	-3.7	54	4.0	78	40.3	72	6/91
Everex Systems Fremont,Calif.	10.4	96	6.1	40	2.4	94	-27.1	89	7/91
Fluke Mfg., John Everett,Wash.	10.1	97	-11.5	67	4.2	75	89.2	22	9/91
ESCO Electronics St. Louis,Mo.	10.0	98	-43.1	93	2.1	97	-21.7	88	9/91
Amphenol Wallingford,Conn.	10.0	99	-13.1	68	2.0	98	42.9	69	12/91
Datapoint San Antonio,Tex.	10.0	100	-27.0	80	3.8	80	43.0	68	7/91

*Capital outlays to net cash flow after dividends

List includes only EB 200 companies that generate 50% or more of their total revenue from electronics sales

Source: ELECTRONIC BUSINESS

Fragmenting memory market offers second chance to U.S. test vendors

Japan still dominates this $300 million market, but U.S. strength in flexible testers is a better match for new market needs

By Gil Bassak

The changing shape of memory devices is making the toughest design job in the test business even tougher. Vendors of automatic test equipment (ATE) have always struggled to develop machines capable of testing the latest memory chips—the densest of all IC's. Now, a proliferation of new device types has created new requirements that threaten to fundamentally alter the look of this $300 million market.

Here's the problem. Rather than just sell standard-configuration DRAMs, SRAMs, and other memories, device makers are selling an increasing variety of "specialty RAMs" in an effort to differentiate their products for emerging applications such as multimedia and notebook computing. There are video RAMs, application-specific RAMs, and memories with on-board logic to speed access time. There are even higher-capacity 8- and 16-megabit memories with configurable I/O data paths so they can be used for applications with lower data path widths.

"NEC now has 300 to 400 different DRAMs in its catalog," notes Dan Hutcheson of San Jose-based VLSI Research Inc. "A few years ago, there were five or six."

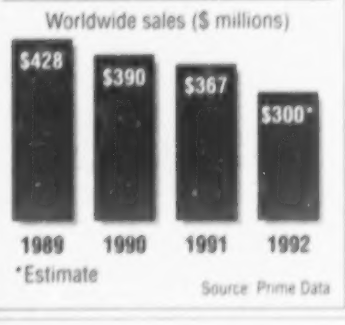
This increased diversity is scattering ATE vendors' finely tuned business plans to the wind. Rather than design racehorse machines engineered to test a handful of standard chips as rapidly as possible, they must create more flexible, versatile products. And while vendors could safely plan on spending the $45 million or so it typically takes to bring a next-generation memory tester to market, this proliferation of device types will throw the predictable two-to-three year cycle between DRAM generations off schedule.

"Before, we basically knew what kind of tester to design, but even the memory manufacturers don't know where the market will be three years from now," says Mark Allison, director of memory product marketing for Megatest Corp. in San Jose. "It's much more of a gamble for ATE companies now. In the end, whoever makes the best guess will win."

But the odds aren't exactly even. In fact, Megatest and Boston-based Teradyne Inc., the last surviving U.S. vendors of memory testers, suddenly hold trump cards in the form of new products that are designed for greater flexibility. These products feature tester-per-site architectures that allow customers to test more than one device at a time. Meanwhile, Japanese market leaders such as Advantest Corp. and Ando Corp. continue to push the straight-away speed of their shared-resource architecture machines.

"The U.S. vendors have taken back the technical high ground," says VLSI's Hutcheson. "That doesn't always translate into commercial success, because customers have shown that they are willing to live with older testers, but the U.S.

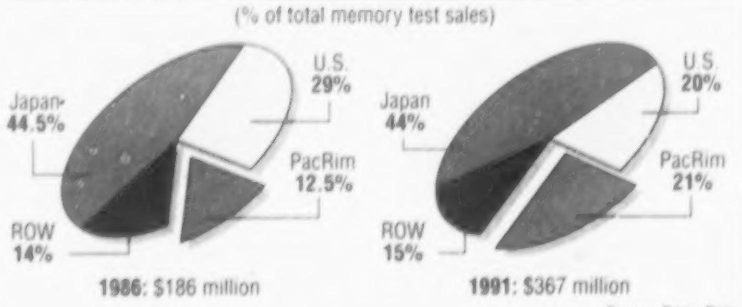
Memory test sales battered...



*Estimate

Source: Prime Data

...but PacRim shapes up as hottest new market



Source: Prime Data

companies have now merged back into the stronghold."

Indeed, efforts to build market share have been slowed by the dismal state of the market in general. Drastic cuts in capital spending by Japan's chip houses should cause memory test revenues to fall from $367 million in 1991 to about $300 million this year, says market researcher Ken Neff with Prime Data in San Jose—the third year of decline in a row.

Still, Megatest and Teradyne have both grown faster than their top Japanese competitors, says Hutcheson—in itself a remarkable turnaround for a U.S. industry left in shambles in the wake of the Japanese invasion of the memory chip market in the 1970s. In fact, it seemed certain the U.S. would be left unrepresented until Teradyne shocked the market by unveiling a new model in 1987. The company has now climbed back to second place with a 16% market share, still far behind Advantest at 39%.

Customers confirm forecasts of a U.S. resurgence in memory test. "We are impressed with how far [the U.S. vendors] have come," says Marvin Strong, a test department manager with memory maker Micron in Boise, Idaho. Admitting that he is "absolutely partial" to American vendors, he is optimistic that they can provide a product that is at least as good, if not better, than the Japanese competitors. "We find them flexible and eager to work with us, and there are no communication or competitive barriers."

Japanese competitors, for their part, recognize the threat but downplay it. "Sure, we'll lose sometimes," says Larry Debattista, manager for technical information services for Advantest America. "But not often."

How much ground can be made up? Ed Rogas, vice president and general manager of Teradyne's chip test division, feels his company can increase its memory market share to 30% by 1995. That may be ambitious, as makers of the largest volume devices served by Japan's rocket-fueled testers will most likely not be swayed by the added flexibility.

There is another advantage awaiting the U.S. vendors, however, says Prime Data's Neff. With much DRAM production moving from Japan to the Pacific Rim, U.S. vendors will face fewer "cultural impediments," such as the close *keiretsu* relationships the major Japanese vendors enjoy with major IC houses. Neff says that memory tester sales to the Pacific Rim nations have increased from 0.5% of the market in 1980 to 18% in 1990, making it the world's fastest-growing regional market. "The key limit on growth is the region where the devices are produced," confirms Rogas. "As the memory business goes away from Japan, it will be easier for us." Korea has been especially fruitful with large sales to Samsung, Goldstar, and Hyundai, he says.

Cost is also a key to greater market share, however. Faced with their own skyrocketing development costs, fierce competition, and cyclical markets, memory makers are in no mood to pay a premium for new machines. Top-of-the-line production testers often cost upwards of $1.5 million, and some studies claim that test already chews up as much as a third of a DRAM's total cost.

Micron's Strong, for one, is not rushing to buy a new machine. The company's policy is to buy only testers that can handle at least one generation into the future, and Strong's team is currently working to extend their current machine to its third

ATE's struggle with device diversity

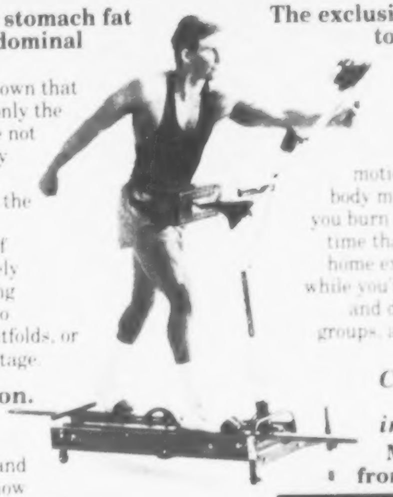
As DRAMs progressed in capacity from 256 kilobits to 1, 4, and—by next year—16 megabits, applications have forced the I/O data path to expand from 1 bit to 4, 8, and 16 bits wide. Now, device vendors are taking advantage of the added capacity by offering configurable devices that let customers choose the I/O data path they require. Laptop and notebook computer makers, for example, will be able to reduce their chip count by using high-capacity DRAMs with low-width I/O paths—a fundamental advantage that slashes space, power requirements, and operating temperature.

Unfortunately, the increased flexibility and density of these devices reduces the machines' capacity to test chips in parallel, thereby reducing throughput. Greg Armstrong, manager of application specific memory products with Dallas-based Texas Instruments, sees the effect of increasing I/O width like this: "We've been sending 64 skinny people through a doorway, but suddenly some of them are four times as wide." What that means for the tester, he adds, is that it must be able to reconfigure itself to handle devices of various widths. In practice, it means testers must be programmable and reconfigurable on the fly.

"Relatively narrow, slow-poke devices are turning into very wide, blazingly fast devices, and DRAM testers will need to handle that," says TI's Greg Armstrong

To make matters worse, DRAM makers are adding logic circuitry to their wares to match the speed gains achieved by microprocessor makers in recent years. Armstrong reports that TI, for example, is building DRAMs that run as fast as 100 megahertz. That's great for TI's customers, but tough on testers. "Relatively narrow, slow-poke devices are turning into very wide, blazingly fast devices, and DRAM testers will need to handle that." However, that requires a level of flexibility that DRAM ATE vendors are unaccustomed to delivering, he says. ☐

Why it takes legwork to flatten your stomach.



You can't reduce stomach fat by exercising abdominal muscles alone.

Research has shown that exercises that work only the abdominal region are not effective. They simply don't involve enough muscle mass to burn the calories necessary to trim fat. Instead of flattening, they merely strengthen underlying muscles, providing no reduction in girth, fatfolds, or total body fat percentage.

The exclusive NordicTrack' total-body aerobic exerciser is the most effective way to flatten your stomach.

The total-body motion involves *all* major body muscles. Which means you burn more body fat in less time than with any other in-home exercise machine. And while you're at it, you're toning and defining those muscle groups, as well. So you feel as good as you look.

Free information.

Call or write us today. We'll send you a free brochure and video that describe how NordicTrack can flatten your stomach and make you look and feel your best.

Call today for a 30 day in-home trial!

Models priced from $299 to $1,299.

Call or write for a
FREE VIDEO
& Brochure

1-800-328-5888 EXT. 14412

NordicTrack, 141 Jonathan Blvd. N.
Dept. #14412, Chaska, MN 55318
[illegible]

NordicTrack

"The World's Best Aerobic Exerciser."

THE GAINERS.
THE REBUILDERS.
THE GAMBLERS.
THE IMPROVERS.
THE NEWCOMERS.
THE INVESTORS.

NOW
AVAILABLE
ON DISK

The Largest. The Richest. The Electronic Business 200.

This annual is the only single directory of company performance in the industry and it is now available on disk for your permanent records. The top 200 electronics and computer companies in America are ranked in terms of sales, growth, profitability, productivity, R&D, foreign sales, and other financial data.

This invaluable reference tool is available on an IBM-compatible Lotus 1-2-3 formatted disk or an Apple Microsoft Excel formatted disk. This year's Electronic Business 200 is now available, as well as results for any three years (1987, 88, 89, 90, 91).

ELECTRONIC BUSINESS 200 AUGUST 1992 15TH ANNUAL

☐ Yes Jean, I would like to receive a copy of the Electronic Business 200 on a disk.

Format ☐ IBM compatible Lotus 1-2-3 ☐ Apple Microsoft Excel ☐ 1 year ($100.00) ☐ 3 years ($200.00)

circle choices: 1987, 88, 89, 90, 91 (prices include postage and handling charges)

I've enclosed a check for $

Name Title

Company

Address

City State Zip

Telephone

To order please send a check payable to Electronic Business and the order form to:
Ms. Jean O'Brien, Electronic Business, 275 Washington Street, Newton, MA 02158. Tel 617/558-4257

DRAM generation. In the meantime, they search for a product that can test memories with 4-gigabit capacity.

How can ATE vendors deliver new products and not price themselves out of the market? For one, customers say they must spend engineering dollars to create upgradable machines that could meet changing requirements—a big change in philosophy for ATE's old-school ironmongers. "The tester maker sees his job as convincing you that the time to buy a new tester is now," says Tom Thorpe, manager of worldwide quality and reliability assurance for Dallas-based memory maker Texas Instruments Inc. "An upgrade is a lot cheaper, but it doesn't hack it for them." Maybe it should. As things stand now, most DRAM makers still maintain in-house test groups to make equipment where commercial vendors fall short.

ATE vendors must also use technology to drive down cost rather than to always push performance. Teradyne, for example, decreased the price of its new J990 series by leveraging the proprietary E/MOS technology developed for its J971 VLSI chip tester. This design, which replaces expensive and power-hungry ECL technology with more efficient CMOS technology for 90% of the critical circuitry, reduced the cost of the J971 from over $11,000 per pin for the previous generation to less than $8,000 per pin. In the J990, the E/MOS technology allowed designers to reduce the total parts count by over 90%.

Another cost-saving option is to buy canned pin electronics solutions from commercial IC suppliers such as Analog Devices Inc. and Brooktree Corp. While most ATE makers still design their own, ATE marketing manager Bill Gotschewski says ADI has added an average of one of ATE's small coterie of vendors to its customer list each year since it began addressing the market in 1986. Armed with skilled IC design staffs and robust production processes, these vendors say they can provide the speed and reliability required to help test emerging device types—and fit the ever-increasing number of pins into ever-shrinking footprints. ☐

EDITORIAL STAFF

Publisher: Frank J. Burge
Editorial Director: Lew Young
Editor: John Russell
Managing Editor: H. Garrett DeYoung
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb (San Jose)
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick
Correspondents: Geoff Crane (Seoul), Craig Addison (Hong Kong)
Consulting Editors: Alberto Socolovsky, Lewis H. Young
Senior Production Editor: Karen J. Covey
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Martha Abdella

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Victoria T. Moore

CIRCULATION

Circulation Manager: Ken Evans
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices.
Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

VIEWPOINT

Forget dogma. Let's choose an industrial policy for the times

If you haven't read the roundtable discussion among seven senior executives in this issue of ELECTRONIC BUSINESS, do so now. Honest. The topic is government involvement in our industry. Throughout the discussion, you can hear their ambivalence about how much individual control they can exert over their companies' futures, about how much of their futures are wrapped up in joint efforts within the corporate world, and about how much of it depends on government action.

These are hard questions, largely because the answers vary with time. Real life is never stable. Boom times give way to recessions or stagnations in an endless but not orderly or easily predictable cycle. Change—trite though it sounds—is indeed the constant and the relationship between government and industry must change to match the times.

Today, we need a closer relationship between the two. We need a clearly articulated industrial policy. That policy, whatever its particulars are, should focus on the renewal side of the economic cycle. It should aggressively tackle the jobs of increasing work force competence, increasing capital formation, and stimulating the creation of new companies. It must also recognize the realities of the global market.

Frankly, many of these changes directly threaten established businesses. Too many of the giants are no longer jobs-creation and wealth-creation machines. Many are at the tail end of the economic cycle. Downsizing may be good and proper for them, but it is not particularly buoyant for the economy as a whole.

How do we, as individuals and as an industry, help bring about these needed changes? As the jointly sponsored ELECTRONIC BUSINESS/American Electronics Association roundtable discussion indicates, we must influence the political process. We must make business issues, in very specific form, become part of the core of the election debate. We must not be dogmatic. We must understand that the proper relationship between government and business changes. We must debate what that change should be and we must recognize that, whatever formula we come up with for the next decade, it isn't a permanent solution. It's simply a match for the times.

—John Russell, editor

ELECTRONIC BUSINESS® (ISSN 0163-6197 GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc. used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA. Robert L. Krakoff, President and Chief Executive Officer. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140 air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $6.00 USA and $11.00 foreign. Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP

NOTE

ONLY THE FOLLOWING PAGES OF THIS

PUBLICATION HAVE BEEN FILMED

Cov. 1, Pgs: 2, 3, 9, 10,
12, 14, 27, 28, 34-38, 47,
48, 50, 52, 54, 60-62, 64,
66, 85, 86, 88, 90, 143-
145, 158

C 1850 8A

Asia's 50 top electronics companies expect a flat '92
PAGE 143

How to navigate the client/server market
PAGE 147

Electronics bankruptcy rates post another high
PAGE 9

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE
OCTOBER 1992

SPECIAL QUALITY ISSUE

FINALLY, THE PIECES COME TOGETHER

After years of trying, industry finds some answers to the quality puzzle:

How to make the Baldrige work
Page 34

Measuring return on quality
Page 60

Gauging customer satisfaction
Page 73

Where managers can learn more on quality
Page 85

AT&T has two divisions in the Baldrige hunt
Page 95

Electronic Business

VOLUME 18, NUMBER 13
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE
OCTOBER 1992

COVER STORY

PRODUCT DEVELOPMENT & MANUFACTURING

34 Forget the nitpicks! The Baldrige is working

Its many critics dismiss it as an expensive and meaningless beauty contest. The evidence, though, suggests that the award has finally added some much-needed structure to decades of unfocused corporate energy. In the process, it has snapped the electronics industry out of its long-standing complacency about product quality and customer satisfaction

Cover illustration by Tom Szumowski

UPFRONT

Business Trends

9 Bankruptcies in electronics rose sharply during past year; Computer sales boom in college bookstores; Transportation a huge market for IS vendors; How voice processing vendors buck the economic doldrums

PAGE 9 Bankruptcies are up, while debts are down for the year

Companies to Watch

21 Ultra Clean Technology Systems and Services brings Japan's clean room know-how to the U.S.; Finisar lowers cost of high-speed data links; Third Coast Software makes sense of test data

PAGE 21 Ultra Clean Technology Systems & Services president Hisayoshi Kobayashi

Business Barometer

27 **Profit outlook**
Revenue growth to drive profits forward in 1993

27 **Labor outlook**
Electronics employment won't improve until late '93

28 **Leading indicator**
Leading indicator jumps in August

PAGE 95 "Transfer of knowledge is much of what this job is about," says AT&T's Phillip Scanlan

PAGE 109 CEO Bob Heller and mascots of ACI's "Seal of Approval," a program designed to keep morale—and quality commitment—high

PAGE 115 "Expecting bottom line results [from quality management] is really a mistake," says Raytek CEO Cliff Warren

FEATURES

PRODUCT DEVELOPMENT & MANUFACTURING

47 **TQM reality check: It works, but it's not cheap or easy**
Despite criticism, most companies agree that quality improvements pay off

60 **What is return on quality, and why you should care**
Calculations often show huge payoffs, but ROQ may be a concept ahead of its time

73 **Do you really know what your customer wants?**
How some electronics companies see themselves through customers' eyes

85 **Industry to B schools: Smarten up on TQM or else**
Business schools better get quality into their curricula or their grads won't get work

95 **AT&T started a quality bonfire to learn how to put it out**
How the company's program paid off by producing two Baldrige contenders

109 **Linking shop workers to customers drives ACI's quality**
The tiny board manufacturer knows how to motivate employees through a long push for the Baldrige

115 **"The point is to keep the customer from becoming unhappy"**
Even if all the returns aren't visible, says Raytek's Warren, TQM satisfies customers

121 **Tough talk—not praise—makes Motorola quality meetings work**
This division concentrates on what went wrong and how to ensure it doesn't happen again

127 **Tying pay to quality cuts defects, boosts yields**
Companies report impressive gains by making workers "financial stakeholders"

FINANCE & ECONOMICS

139 **Commentary**
After major revisions, what do the industry numbers really mean?

INTERNATIONAL

143 **Recession walloped Asia's electronics industry, too**
The downturn slashed net income at top companies in '91

MARKETS

147 **Client/server tools are here, but so is buyer confusion**
The proliferation of products could overwhelm users and sink a few tool vendors

DEPARTMENTS

My View *By Frank Burge, publisher*

155 My barber looks at education

Company Index

156 Companies covered in this issue

Advertiser Index

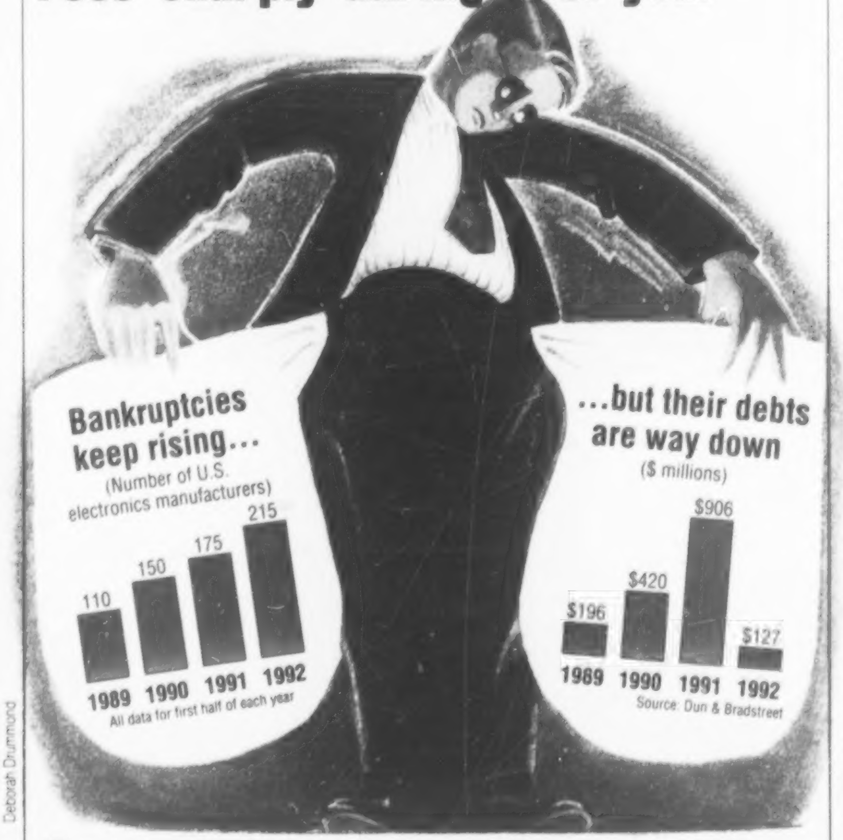
156 Advertisers covered in this issue

Viewpoint *By John Russell, editor*

158 Are we falling out of love with TQM?

ECONOMICS

Bankruptcies in electronics rose sharply during past year



Deborah Drummond

As ANOTHER INDICATOR of just how tough this recession has been, Dun & Bradstreet reports that 215 companies went under during the first half of 1992 in electronics and electrical manufacturing alone. That compares with 175 bankruptcies during the same time period last year and 150 two years ago.

The D&B data shows that other industry sectors are also under fire. The computer services and data processing sector registered 351 company closings during the first half of 1992, up from 280 during the same period of 1991. Among instruments manufacturers, 94 succumbed to the erosion in their balance sheets, up from 80 in 1991. U.S. corporate bankruptcies in all industries rose 17% during the first half of 1992.

"Business failures have been rising since April 1990, underscoring the breadth of the recession," says Joseph W. Duncan, corporate economist for D&B in New York. Duncan notes that small service businesses in California and New York have been particularly hard hit. As for the future, "failures will most likely continue to rise during 1992, but by year-end they may flatten out on a year-over-year basis," he says.

If there's any good news in the bankruptcy reports, it's that outstanding liabilities by the bankrupt electronics companies have fallen dramatically: The 175 electronics manufacturers that closed their doors during the first half of 1991 left $906 million of liabilities, versus only $127 million for this year's 215 bankrupt companies. That indicates that more small companies have gone under, whereas larger companies may have begun to stabilize.

The liabilities figures also suggest that many companies that had cut their debt significantly from 1991 to 1992 "still find themselves in trouble," notes Maddy Franchi, senior economist with Cahners Economics in Newton, MA. "For example, Wang Laboratories announced in August that they'd gone into Chapter 11, but their liabilities now are much less than they would have been a year ago."

For the few that eventually come back from bankruptcy, the transition isn't easy. One success: Tie/Communications Inc., a communications equipment company based in Seymour, CT, that this summer reported its first quarterly gain since emerging from Chapter 11 in July 1991. But those profits do not come without painful restructuring and, some say, a serious cost to U.S. manufacturing competitiveness. The company's manufacturing and R&D business was sold to NTK America. Tie/Communications now operates as a sales and service company.

—E. B. Baatz

VENTURE CAPITAL

Investors say money is there for good ideas

TIRED OF HEARING entrepreneurs complain that venture capitalists are shunning early-stage financing deals in favor of less risky later-stage deals, the venture community wants to set the record straight. While it's true that less money is being disbursed in seed-and development-stage deals, the number of *successful* venture-funded start-ups today is the same as during the heady mid-to-late 1980s.

The problem, say general partners, is that people equate the excess amount of capital available four to six years ago with a "healthy" venture-capital market. The fact is that too much of the $4 billion in funds created in 1987 went to too many marginally viable or unsuccessful start-ups.

"For years, I have read all the whining and whimpering about the availability of seed money," says Don Valentine, general partner of Sequoia Capital in Menlo Park, CA. "What people don't realize is that the whiners and whimperers are those who don't have a concept worth funding. There's plenty of seed money available."

Other partners tend to agree with Valentine: You can't compare today's market with those of the past, when disbursement depended more on availability than on good business plans. "There are only so many bright people out there with bright ideas," says Gib Meyers, general partner of the Mayfield Fund. "We pay attention only to the ones we feel can excellently manage an excellent idea. That's basically what we've always done and will continue to do."

—David Webb in San Jose

COMPUTER MARKETING

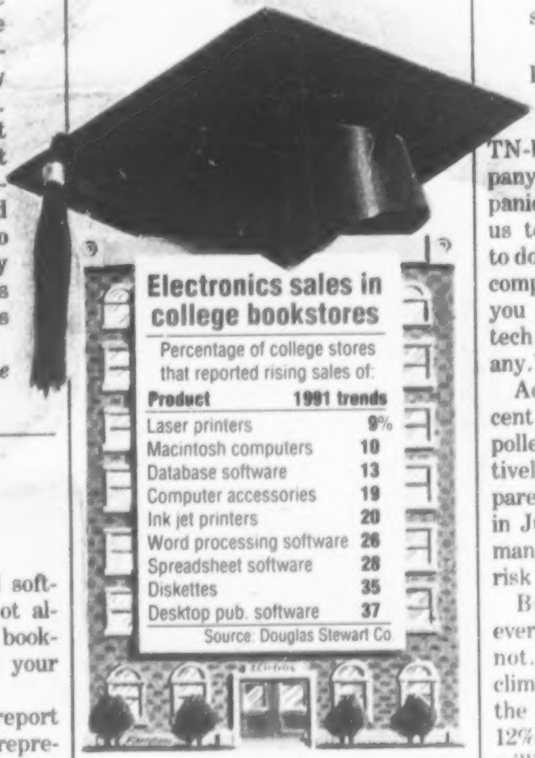
Computer sales boom in college bookstores

ATTENTION computer and software vendors: If you're not already on the shelves of college bookstores, you're missing out on your share of a $7 billion market.

Buyers for college stores report that software and computers represent their biggest sales opportunity, according to a survey of 227 college stores by the Douglas Stewart Co. in Madison, WI. Sales of computers, software, printers, and diskettes in those stores are growing. Desktop publishing software sales were up in 37% of the surveyed markets, diskette sales were up in 35%, ink jet printer sales were up in 20%, and Macintosh sales were up in 10%.

It also appears that college buying patterns are recession-resistant. While 36% of the respondents claimed that the recession has had an impact on sales, 60% of college buyers reported either that the recession had no effect or that sales actually increased. Forty-four percent of computer product buyers said the recession had no effect on their sales.

Other research shows that buying patterns established in college are likely to continue, says Douglas Stewart's Scott Bukolt. Both IBM and Apple have independently determined that brand loyalty, as well as system upgrades, continue after college.



Electronics sales in college bookstores

Percentage of college stores that reported rising sales of:

Product	1991 trends
Laser printers	9%
Macintosh computers	10
Database software	13
Computer accessories	19
Ink jet printers	20
Word processing software	26
Spreadsheet software	28
Diskettes	35
Desktop pub. software	37

Source: Douglas Stewart Co.

Joe Farnham

How valid are college stores as a sales channel? That depends on location, says Bukolt. Rural campuses have an essentially "captive" market; campus stores in urban areas suffer price competition from mass merchandisers but are getting more competitive in price and selection by changing product mixes and improving inventory management.

An even distribution of college buyers were interviewed from each of the three major groups of college products: general merchandise, computer products, and consumer electronics. About 85% of buyers represent stores in markets with four-year colleges.

—Barbara Jorgensen

CORPORATE FINANCE

For electronics, banks are more talk than money

MOST BANKS WOULD have you believe that they're earning their way back to health by rolling out the welcome mat to small and midsize companies. According to one expert, however, most electronics companies find loans almost as scarce now as a year or two ago.

"There are facts and there are perceptions," says John Meatte, CEO of First Financial Banc Corp. (FFBC), a Cookeville, TN-based credit structuring company specializing in electronics companies. "The perception banks want us to believe is that they're eager to do business with small and midsize companies. The reality is that when you ask them about loans to high-tech companies, they aren't making any."

According to the FFBC's most recent survey, 61% of the 410 banks polled at the end of May were actively seeking new business, compared with only 18% of those banks in June 1991. That's good news for many profitable, high-visibility, low-risk companies.

But those qualities represent everything electronics companies are not. So while lending in general climbed by 29% this year, loans to the electronics industry rose by just 12%. And while more banks may be willing to talk to electronics companies, the lending criteria for those companies are far tougher than for most other industries. An appliance manufacturer, for example, gets more favorable treatment by banks than an electronics company because the bank could sell off the former's inventory more easily than it could a collection of diodes and circuit boards. Maybe that's why only .06% of the country's banks are lending to high-tech companies.

The ramifications extend far beyond those companies that are unable to convince banks that they are worth the investment. "If companies that have growth potential have trouble getting money, that leaves them vulnerable to foreign sources of capital," says John Baumeister, vice president of business support services for the American Electronics Association and president of AEA International. "The situation is very critical, and I'm concerned it will get worse."

Don't put all the blame on the banks, though. The companies most in need of money need to realize they're not playing on the same turf as a few years ago. "The electronics industry has a lot of growing up to do," contends FFBC's Meatte. He cites a high-tech company with $150 million in revenue that was borrowing money at 8% from a leasing company. When a bank offered a loan at 4.4%, the company declined because it didn't want to follow the bank's requirements.

"That dogmatic approach is costly and stubborn," Meatte says. "[Electronics companies] don't understand how to help themselves. They just won't face reality. I guess when it gets bad enough so they have no choice, the companies will comply [with banks' requirements] by default, not by design."

—Willie Schatz in Washington, D.C.

INFORMATION SYSTEMS

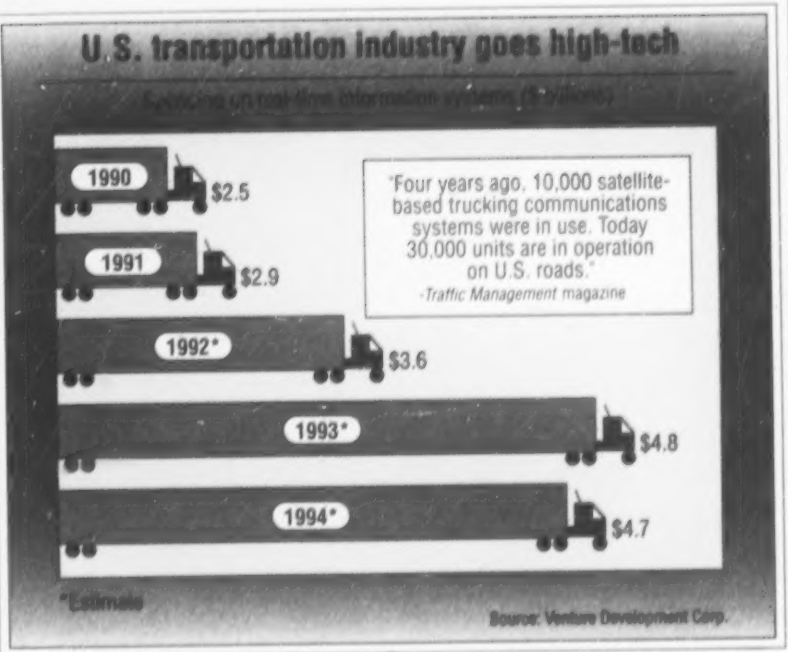
Transportation a huge market for IS vendors

THE TRANSPORTATION industry's spending on information systems (IS) is ready to skyrocket, according to Natick, MA-based consulting firm Venture Development Corp. Airline, trucking, parcel delivery, railroad, and shipping companies spent a total of $2.9 billion on real-time IS last year and are expected to boost that by 24% in 1992 and another 33% in 1993.

The spending boom is due to a confluence of three temporary factors. First, spending was delayed in the past two years due to the economic slowdown and will be catching up in the next two years. Second, following a gush of spending on satellite communication systems, trucking companies will now be spending more on mobile computing and wireless communication carrier services. Third, the railroad industry is expected to shift from bar-coded automatic identification systems to radio-frequency ID tags.

U.S. transportation industry goes high-tech

Spending on real-time information systems ($ billions)



"Four years ago, 10,000 satellite-based trucking communications systems were in use. Today 30,000 units are in operation on U.S. roads."
-*Traffic Management magazine*

*Estimate

Source: Venture Development Corp.

Not everyone agrees with Venture Development's figures. Based on interviews of IS managers in the transportation-services sector, Business Research Group of Newton, MA, predicts that budgets will increase only 2% this year. That estimate, however, includes only those companies sophisticated enough to already have an IS manager. If low-tech transportation companies plan to compete in this high-tech world, one should expect those budgets will be ballooning—and more IS managers will be hired.

—E. B. Baatz

MARKET DEVELOPMENT

Forum is designed to help forge new business in Japan

FRUSTRATED WITH cultural and political barriers to developing new business and partnerships with Japanese companies in Japan? If so, help may be at hand. U.S. executives are being invited to meet with their Japanese peers in Tokyo December 2-4 to discuss bilateral trade issues, as well as how U.S. companies can develop new business in Japan.

The Alliance Forum (formerly known as Networking Japan) aims to foster mutual understanding between corporate America and corporate Japan without the protocol-ridden atmosphere of government-sponsored meetings. Any company seeking to finance global growth strategies, expand marketing and distribution, or explore partnership opportunities with Japanese companies is encouraged to attend.

"[The meeting] is designed to expedite cooperative ventures between American and Japanese companies," says George Hara, Alliance executive committee chairman. "Several companies [in the past] have successfully completed business negotiations as a result of the conference, and thanks to the support and participation of influential executives on both shores, we are able to improve the state of trade at a grass-roots level."

To sell in Japan requires establishing local distribution, offices, and a business entity. The forum is designed to introduce U.S. executives to Japanese manufacturers, technology providers, consultants, trading companies, and investors.

For more information and registration materials, contact the Alliance Forum at 601 Gateway Blvd., Ste. 425, South San Francisco, CA 94080. Phone: (415) 742-0757.

—*David Webb in San Jose*

TELECOMMUNICATIONS

Voice processing bucks the economic doldrums

SOME CALLERS just can't overcome their distaste for voice-messaging systems, but you won't hear many complaints from people who have invested in the voice-mail vendors. Many of these suppliers posted record results last year, and 1992's quarterly financials just keep getting better. Overall, the voice-mail market grew to $983 million in 1991, up 22% from the previous year, according to Probe Research Inc. of Cedar Knolls, NJ. Recession? What recession?

Many companies acquire a voice-mail capability as an option packaged with their private-branch exchange (PBX) phone systems, and the leading PBX vendors hold more than one-third of the market (see chart). But independent supplier Octel Communications Corp. of Milpitas, CA, led the pack in 1991 with a 21% market share, according to Harry Schwedock, editor of Probe Research's *Voice Processing* newsletter. For its fiscal year ended June 30, Octel's net revenue hit $188.8 million, up 18% from the previous year. Net income was $21.4 million, a 21% rise from fiscal 1991.

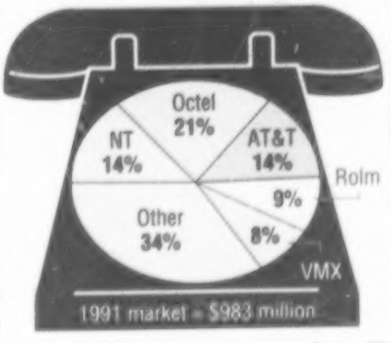
VMX Inc., the second-largest independent supplier, saw its fiscal 1992 (also ended June 30) revenue jump 25%, to $71 million. The San Jose company's fiscal '92 net income totalled $4.7 million, following a net loss of $4.1 million the previous year. At Dallas-based InterVoice Inc., revenue climbed 48%, to $30.2 million, for its fiscal year, ended February 28. Net income, however, fell 19.5% to $2.9 million. And some of the voice vendors failed to participate in the industry's overall growth altogether. Revenue at Phoenix-based Syntellect Inc., for example, dropped 20.2% during 1991, to $28.9 million, and the company experienced a net loss of $2.1 million.

For two to three years, the main trend driving the voice industry has been the consolidation of several voice technologies into single systems. The mainstay voice-mail messaging function still accounted for about 80% of the industry's 1991 sales, estimates Schwedock, but vendors have been adding other capabilities, once sold separately, such as "interactive voice response (IVR)" and "audiotext" to their systems. IVR forges a link between voice systems and information stored in computer databases; audiotext is familiar to people who call numbers provided by newspapers or other sources to hear traffic reports, weather forecasts, or other information.

Octel rose to the top of the voice-processing marketplace by focusing on the *Fortune* 1000 marketplace and meeting the sophisticated demands of these large corporate purchasers. The vendor's top 25 customers each own an average of 88 Octel systems, according to Mike West, an Octel executive VP. The company has also done well selling to the Bell Operating Companies and phone service providers. And, with its recent acquisition of Sarasota, FL-based Compass Technology Inc., Octel now has a system suitable for companies with 100 or fewer employees, according to West.

Octel rings in with top share of world voice-mail market

(Market share by company, 1991)



Source PRI

Perhaps best of all from Octel's perspective, fewer and fewer callers object to getting a machine on the line rather than a person. "Many people have decided that knowledge from a machine is better than lack of knowledge from an individual," says West.

—*Dwight B. Davis*

COMPUTERS

Open systems losing their price advantage

THE GOOD NEWS for vendors of open systems is that their share of the U.S. computer and software market will double by 1996. The bad news is that those vendors are losing their price advantage.

U.S. sales of so-called open systems—computer hardware, software, and networking components designed around industry standards—will jump from $23.2 billion in 1991 to $81.2 billion in 1996, according to Frost & Sullivan International, a New York-based research firm. Standards-based products will account for 36% of the total U.S. market by 1996, more than twice their current market share.

But manufacturers of computers based on proprietary architectures have been eroding the price advantage held by vendors of open systems, says Roger Hart, an analyst with the CSC Index research firm in London. Computer makers such as Digital Equipment Corp. have fought back by offering their own lines of open systems and by grafting standards such as Posix (portable operating system interface for Unix) onto their proprietary technology.

"As proprietary systems become more open, they compete with open-system pricing, thereby reducing the cost advantage once enjoyed by open systems," Hart says. "And the traditional vendors keep their market share." Hart warns that vendors of open systems cannot sell themselves on price alone. Product quality and reliability and ease of application generation are the major selling points today, he says.

—*Rick Whiting*

PROFIT OUTLOOK

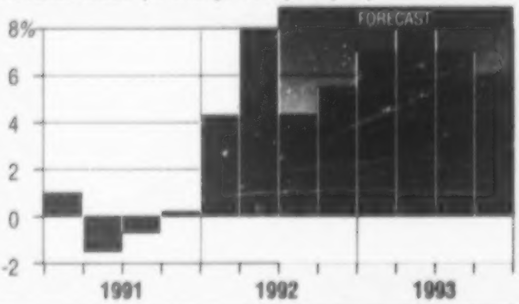
Revenue growth to drive profits forward in 1993

DESPITE THE stop-and-go nature of the economic recovery, electronics industry sales are maintaining steady, although moderate, growth—and that's good news for the 1993 profits outlook. The ELECTRONIC BUSINESS revenue index, representing a cross section of the electronics industry, shows the industry's recovery is progressing right on track. After retreating 0.3% last year—the first decline since 1975—the revenue index expanded 4.3% during the first quarter of 1992 over year-ago levels and jumped 8% again in the second quarter. Look for total industry revenue to rise 5.5% in 1992 and 6.9% in 1993.

The upward trend in revenues is materializing at the just the right time to improve the profits performance of newly reorganized companies. The ELECTRONIC BUSINESS profit index fell over 88% last year as several companies in the index bled red ink. The profit index had risen during the first quarter of 1992 but slipped again below zero during the second quarter due to the substantial losses and massive restructuring charges reported by Digital Equipment Corp. Excluding DEC, the profit index shows industry profits in the second quarter of 1992 climbed 2.9% from the first quarter and surged a whopping 243% from the bleak second quarter in 1991. The profits index overall is expected to climb over 200% in 1993 as revenues grow solidly and restructuring pays its dividends.

—*John Farrell*

Revenue index (% change from prior year)



(Index: 1975 Q1=100)

	Q3 1991	Q4 1991	Q1 1992	Q2 1992	Q3 1992 (FORECAST)	Q4 1992 (FORECAST)	Q1 1993 (FORECAST)	Q2 1993 (FORECAST)
Revenue	540	689	549	601	**564**	**727**	**587**	**650**
Profits	117	-129	218	-57	**150**	**290**	**325**	**335**

Source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

LABOR OUTLOOK

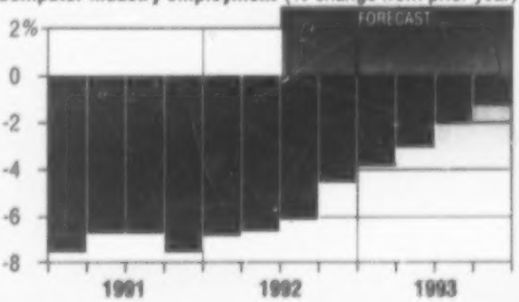
Electronics employment won't improve until late '93

CAHNERS Economics expects employment in the electronics industry to rise slightly from year-ago levels, but not until the end of 1993. In fact, the meager increases will hardly be noticeable. The recession wreaked havoc on employment and the electronics industry fell squarely in the path of the storm. From the end of 1989 to the end of 1991, employment in the U.S. electronics industry shrank by 179,000 workers, or 7.9%. From the beginning of January until July of this year, total nonagricultural employment grew by 446,000 people, but another 52,000 electronics workers lost their jobs.

Employment losses occurred everywhere in electronics manufacturing—computers and office equipment, consumer electronics, communication equipment, electronic components, and instruments factories—but the computer industry suffered the most. Employment in the computer industry has been hemorrhaging since the beginning of 1985. Then, the industry employed almost 340,000 people—1.4 times the number of workers employed today. Just since January 1992, 8,000 people once employed in the computer industry have retired early or are seeking job opportunities elsewhere, and companies continue to announce more layoffs. As of last July, the U.S. computer industry employed only 242,000 people. Watch for average employment declines in the computer industry of 6.1% this year and another 2.5% in 1993.

—*Julie Handelman-Sagan*

Computer industry employment (% change from prior year)

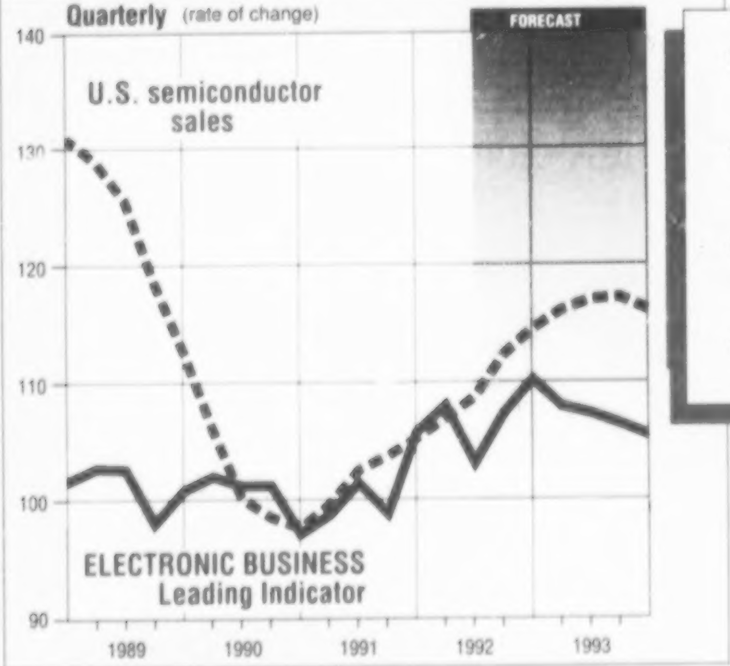


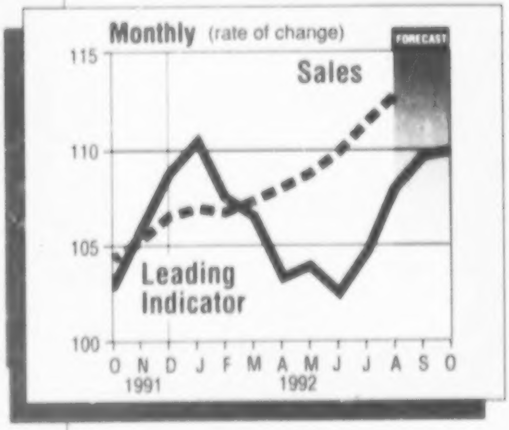
(thousands employed)

	'87	'88	'89	'90	'91	'92 (FORECAST)	'93 (FORECAST)
All electronics	2,292	2,314	2,301	2,225	2,140	**2,054**	**2,045**
Computers	303	298	294	279	259	**243**	**237**

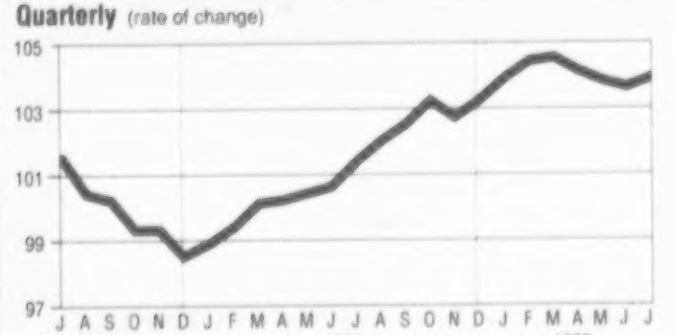
Source: Labor Dept.; Forecast: Cahners Economics

ELECTRONIC BUSINESS Leading Indicator





Hours worked by semi workers slowly lengthen



Source: *Electronics Purchasing* magazine

Leading indicator jumps in August

The ELECTRONIC BUSINESS Leading Indicator (EBLI) climbed from 104.6 in July to 107.8 in August. A year ago, EBLI clearly mapped out the double-dip scenario when it hit a low in August 1991 on the heels of a low in December 1990. In contrast, this year's ascent has been based on consistent growth in semiconductor orders—which are forecast to rise 16% in 1992. With average weekly hours worked by semiconductor workers on the rise, EBLI is painting a brighter picture ahead in 1993.

—John Farrell

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Aug.)	107.8	104.6	98.6	101.1
U.S. semiconductor bookings ($ millions, 3-month average, Aug.)	$1,612	$1,592	$1,215	$1,311
Weekly hours of semiconductor production workers (monthly average, July)	42.5	42.2	40.2	41.1
Electronic components lead time index (1977 = 100, Sept.)	87.9	92.5	81.4	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, Aug.)	87.3	84.3	72.3	68.5
Change in electronic components inventories ($ millions, SA, July)	-$13	$70	$55	-$57
Contracts and orders for plant and equipment ($ billions, SA, July)	$32.4	$34.5	$39.0	$33.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119, fax (617) 630-2100

FORGET THE NITPICKS!

Critics say it's an expensive beauty contest. Advocates say it has improved U.S. industry's quality. Here's the truth

By Peter Burrows

BALDRIGE ANALYSIS

As its fifth year comes to a close, the Malcolm Baldrige National Quality Award remains as controversial as ever. Critics complain that it costs too much to apply for the award, that it can be bought by using high-priced consultants, and that it favors large companies. They further argue that the Baldrige doesn't measure actual financial performance, that it has been awarded to undeserving companies, and that too few companies enter the competition to improve the quality of U.S. industry.

No doubt these criticisms contain some truth, but there are strong counterarguments, too. High-priced consultants certainly helped Xerox Corp. and IBM win Baldrige awards, but they were unable to help Intel Corp. win last year. Moreover, 1991 winners Zytec Corp. and Marlow Industries are hardly giants.

Perhaps most important, while the number of actual Baldrige participants does remain low, U.S. companies have requested more than 50,000 copies of the Baldrige criteria and 10,000 presentations from Baldrige winners, examiners, and administrators.

In the final analysis, the truth is this: The Baldrige program has done more than anything before it to lift U.S. business out of its complacency regarding quality. Industry—especially the electronics industry—has clearly accepted the criteria created by the 250-plus experts on the Baldrige board as a blueprint for improvement.

"We've been following the Baldrige road map for years, so it has become a way of life for us," says Hank Hayes, president of Texas Instruments Inc.'s Defense Systems and Electronics Group, a finalist in this year's contest. "I would suggest strongly that every company pursue the Baldrige criteria. It will improve your whole business."

The Baldrige program has set off a hurricane of interest in Total Quality Management (TQM) that has astounded even its founders. Sitting amidst his frumpy plaque-covered, paper-filled office at the Department of Commerce's National Institute of Standards and Technology (NIST) in Gaithersburg, MD, program director Curt Reimann rattles off evidence of Baldrige's legacy: Baldrige-based quality award programs have sprung up in Minnesota, New York, and North Carolina, with more than 20 more state-level programs in the works; universities, trade associations, and corporations are promoting and implementing the award criteria as the quality improvement system of choice, and seminars, books, and symposia continue to proliferate. There are even off-the-shelf software products to help companies conduct Baldrige self-assessments. "Trying to stay on top of this is like trying to drink from a fire hose," says Reimann, a tireless advocate who gets to work each morning at 4:30 A.M.

Why this maelstrom? Because the Baldrige has put structure behind decades of unfocused corporate energy, says Reimann. While Japanese companies have long adopted the TQM teachings of gurus such as W. Edwards Deming and Joseph M. Juran, Reimann claims "there was no single definition of TQM in the

The Baldrige is working

• Enhance U.S. economic growth
and i mpetitiveness
• Ind cost sharing
• Pr c technology
de
• Ena s - - technical
and age
• Compe

"I won't be concerned [about the declining number of Baldrige applicants] for at least another year," says Baldrige program director Curt Reimann

Patricia Fisher

U.S. prior to 1987. Now there is. "It did what the quality professionals could not do. It got upper management's attention," says Clark Craig, quality head at Lisle, IL-based Molex Inc. and a former Baldrige examiner.

The impact of the Baldrige is even becoming global. The European Quality Award, an EC-sanctioned prize that will be awarded for the first time this year, is modelled on the Baldrige assessment systems and its overall goals. Reimann has recently helped Mexico and Sweden set up Baldrige-style programs. Swedish authorities say they handed out more copies of the criteria in the first 10 weeks than Reimann's office did in the Baldrige's first year.

"We looked at various supplier awards, ISO 9000, the Deming prize, and many others, but the Baldrige was the best tool for quality improvement," says Johnny Lindstrom, president of the Swedish Institute for Quality.

While an award is just an award, some say the Baldrige is helping to brighten the foreign businessperson's view of U.S. quality in general. "The Baldrige Award is extremely important for America," says Cypress Semiconductor Corp. president T. J. Rodgers, a habitual critic of government programs. "You can make all the criticisms you want, but we now have a prestigious national quality award that is respected around the world."

The big question now is "What's next?" Some observers say the United States is losing its ardor for TQM, and the Baldrige program does find itself at a crossroads. Although the Baldrige has a loyal cadre of followers, only 90 companies applied this year, down from a high of 106 in 1991. Worse, an ELECTRONIC BUSINESS poll this summer shows that only 38% plan to apply in the future, down from 49% last year. Those planning to use it for internal assessment fell to 48%, from 56%.

Reimann, who clearly relishes the opportunity to defend the program, fires off well-rehearsed arguments to defend the Baldrige. "It was never designed for mass appeal but instead as a proving ground for the best of the best . . . A new network [of companies interested in TQM] is more significant than a new applicant . . . We couldn't process all the applications if it got much bigger."

Reimann also says that the temporary obsession with ISO 9000 has depleted applications this year as companies rush to become certified to that emerging standard by the December 31 unification of the European Common market [see sidebar]. Most agree that ISO 9000 is a less demanding quality improvement tool than the Baldrige. ◆

"The Baldrige means less and less around here all the time," says Dick Rosen, president and COO of AVX Corp. in Myrtle Beach, SC. "It would be a neat thing to hang on the wall, but not if it costs more than the wall to get." An even more typical view is that of Brooktree Corp. CEO James Bixby. "We see a lot of benefit in the Baldrige, but we're not particularly motivated to apply right now," he says. "The time and energy required would take time away from more direct business issues."

Even past winners are de-emphasizing the

The Baldrige and ISO 9000: It's not either/or

ONE OF THE KEY debates in quality management today is on the merits of the Malcolm Baldrige National Award criteria versus the International Standards Organization's (ISO) 9000 series. Which is the better quality improvement tool?

Recent data suggest that companies are flocking to ISO 9000 and not to the Baldrige. According to a recent ELECTRONIC BUSINESS poll, the percentage of companies that applied for ISO 9000 certification rose from 9.2% in 1991 to 23% in 1992, while the number that applied for the Baldrige fell from 5% to 2%. The number of companies that had plans to go for ISO 9000 in the future fell from 53% to 46% in that time, while the number of companies with plans to go for the Baldrige fell from 49% to 38%.

Unfortunately for ISO 9000 crusaders, the debate between the Baldrige and ISO 9000 is an artificial one. In truth, the rise of ISO 9000 is driven not by commitment to Total Quality Management (TQM), but by companies' desire to earn or maintain business from the growing number of government agencies and companies that demand ISO certification.

"ISO 9000 is required or strongly suggested by more customers all the time, and it is rapidly moving to smaller suppliers," says Mark Morrow, editor of *Quality Systems Update*, a Fairfax, VA, newsletter that tracks ISO 9000.

For companies who have held up their ISO 9000 certificates as proof of quality-consciousness, this marketing windfall will soon disappear. While only 38 U.S. companies have received certification as of yet, Morrow says that "hundreds are now on the threshold." He expects the number of certified U.S.-owned plants to quadruple in the next year.

More importantly, ISO 9000's honeymoon as the next great key to quality is coming to an end. While it is a fine starting point for companies, ISO 9000 still represents a low level of TQM.

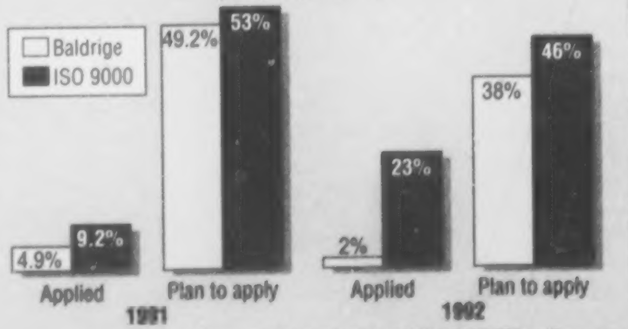
The standards [there are three, each covering slightly different subsets of the product development cycle] only require companies to prove they have basic quality systems in place to ensure their ability to deliver quality products. They don't require companies to prove the *actual* quality of their products, and they don't require that quality systems be deployed throughout the corporation, as the Baldrige criteria do.

"There is definitely a misconception that relates ISO registration with quality excellence, and I don't think there is a direct correlation," says Hank Hayes, president of Texas Instrument Inc.'s defense systems and electronics group in Dallas. A perennial Baldrige applicant and a finalist this year, he notes that his group has had to comply with the Defense Department's ISO 9000-like 9585 standard since 1962, "yet we still found a tremendous overall improvement in quality when we moved to the Baldrige."

"ISO 9000 has taken on such a euphoria and is attractive because you get an actual piece

ISO 9000 outdraws the Baldrige

(% of respondents)



Source: 1991 and 1992 ELECTRONIC BUSINESS quality surveys

Baldrige as they proceed with their quality efforts. Of the four winners from the electronics industry that ELECTRONIC BUSINESS surveyed, only Motorola Inc. will actually do an internal assessment of its operations using the Baldrige criteria this year. [Motorola has trained 92 in-house examiners, using the same training regimen as the Baldrige program.]

Also, many companies have backed away from pledges to require their suppliers to apply for the award, as both Motorola and certain units of IBM have done.

Convex Computer Inc. of Richardson, TX, had plans to require its suppliers to apply for the Baldrige, even though Convex itself had never applied. "When we really sat down and thought about it, we realized that we wouldn't want to be told to apply until we thought we could win," says COO Terry Rock.

There is no doubt that customer strong-arming has been a key driver of the Baldrige's popularity—and an effective vehicle to force suppliers to join the race for higher quality. Of the 399 companies that have applied for the Baldrige since the program began in 1988, 238 of them—that's 60%—are Motorola suppliers, the company estimates.

While many say that the Baldrige has become too clubbish to attract the industry at large, there is no danger of it disappearing soon. A feel-good symbol of a resurgent America, the Baldrige enjoys broad political support from both parties and continued support from corporate powers including Motorola, IBM, Xerox, and Mobil; 1992 finalists AT&T and Texas Instruments; and a few dozen more.

There are steps the Baldrige committee can take to make the award more appealing. Better scheduling is one. Currently, applications become available in February but must be submitted by April 1. Many applicants say they need more time to respond to yearly changes in the criteria. "Going for the Baldrige may be great for the company, but it makes it real tough for the poor S.O.B who has to write down all the answers," says one project leader who worked for eight straight weeks to complete the 98-question application.

Applicants have also complained that they received too little feedback too late, usually in December, which is just months before the April submission deadline. That's now changing. This year, reports were being delivered to some companies as early as late August. Feedback reports are now also longer—typically 20 to 35 pages long.

Peter Pappanastos, VP of quality for 1992 applicant Pyramid Computer Corp. in San Jose, suggests that each applicant—not just finalists—receive a site visit from examiners along with detailed scoring data for each of the criteria's seven sections, rather than one aggregate score.

"If this is truly a tool for U.S. companies to improve, then they should take the time to meet with each company and tell them more

of paper if you pass," notes Motorola Inc. director of quality Richard Buetow, "but it may not ensure satisfactory suppliers."

That's not to say ISO 9000 is not worth doing. In fact, it is worth doing for the best of reasons—to maintain and attract new customers, especially overseas. "The Baldrige did a great job of raising awareness, but ISO 9000 is much more valuable in practical terms," says John Mann, vice president of quality for AVX Corp. in Myrtle Beach, SC. "Last week we had four customers who wanted to know about ISO 9000. We haven't had someone ask about the Baldrige in the last six months."

While most companies realize cost savings from lessons learned in the process of complying with ISO 9000, the cost of getting certified isn't cheap. Companies must pay to bring in a third-party auditor to do the certification assessment as well as follow-on maintenance assessments, which vary depending on the assessor; some do checks every six months, while others only come back once every two years.

Costs can vary widely, however, depending on the company and the assessor. Motorola, which has had 18 facilities certified [15 in Europe], says it spends about $40,000 per site, not including the $150,000 that will be spent over time on maintenance assessments."We do it because we don't know if our customers will require it, but we're not very happy about it," says Buetow. Du Pont Electronics, on the other hand, says it spends about $14,000 for the initial audit and $2,400 for surveillance visits. The company has earned certificates for 22 of its 35 facilities worldwide.

While expensive, many executives had hoped their investment would lead to fewer audits of their facilities by customers. "The idea of third-party certification sounds great, but not everyone signs up for it," says Clark Craig, director of quality for connector supplier Molex Inc. in Lisle, IL. "We still want to see what our suppliers are doing, even if they are ISO 9000 certified. I expect other companies feel the same." ☐

directly how they can improve," Pappanastos says.

Marty McCoy, quality director for Boulder, CO-based Exabyte Corp., another 1992 applicant, agrees. "The only way they really understand is when they come for a site visit. Until then, all you've done is a term paper."

Scores shrink as Baldrige judges get tougher

(1,000-point scale)

	1988	1989	1990	1991
Average score	610	663	486	408
Number of applicants	66	40	97	106
Number of winners	3	2	4	3

Source: American Society of Quality Control

Average scores have dropped considerably since the Baldrige program began in 1987. Not only have examiners learned more about how to analyze companies, but the criteria has been tweaked to focus more on the results of quality efforts rather than on organizational issues

Possibly the greatest threat to the Baldrige, therefore, is that it will change *too* fast. For example, when the Baldrige committee was preparing to change the 1992 criteria to give greater weight to bottom-line financial performance—something it ultimately did—Motorola quality director Richard Buetow unsuccessfully argued with Reimann for four hours not to do it.

"I think they're moving too fast; I'm afraid they are just answering the critics," says Buetow. "The Baldrige examiners are simply not competent to analyze all the different market segments they see or to calculate the proper rates-of-return for each," he says.

Indeed, pressure to extend the Baldrige criteria into non-traditional quality areas seems likely to increase. Many fear this could discourage participation in the program and dilute the value of the criteria as a quality improvement tool. New York State's Excelsior Award, for example, is administered by the N.Y. Department of Labor and includes a section dealing with labor-management issues.

Reimann says that the Baldrige committee is sufficiently buffered from political forces that might try to impose new values on the program.

Let's hope it's sufficiently protected. The Baldrige criteria "is neither so narrow that it is uninspiring, nor so broad as to be unmanageable," Harvard University Business School professor David Garvin pointed out in a *Harvard Business Review* article last year. The Baldrige has obviously struck a nerve in the boardrooms of America. Trying to do too much with it could chase would-be applicants away.

Benefits of the Baldrige at IBM

(Medal-winning divisions versus IBM at large)

Customer satisfaction	6% higher
Employment morale	3% higher
Market share	7.4% higher
Revenue	Grew
Profits	Grew

Source: IBM

All major business organizations at IBM must do annual self-assessments using the Baldrige criteria, and management hands out bronze, silver, gold, and chairman's awards to those that score within predetermined ranges. Do these exercises translate to business succes at Big Blue? In a study that began in early 1991, the 18 medal-winning organizations have outperformed the corporation by most key measures

In the final analysis, the best benchmark of the Baldrige's effectiveness is the record of past winners:

- Despite the dismal condition of its market, IBM's minicomputer division in Rochester, MN, (1990) has prospered by doubling the number of new customers and improving market share by 18%;
- San Jose-based contract manufacturer Solectron Corp. (1991) continues to grow by leaps and bounds. After three quarters, it exceeded 1991 sales by 9%;
- Even General Motor's Cadillac division (1990), a much maligned choice when announced, has muted many critics; sales of its redesigned Seville jumped from 150 to 600 in Japan last year and earned accolades as one of Japan's top five imports of the year.

There have been some riches-to-rags stories. For example, oil field equipment distributor Wallace Corp. (1990), which declared bankruptcy this January, seems to have been more the victim of the protracted slump in the oil business and the ill-timed failure of its bank rather than from than from the widely reported explanation that management was too busy making Baldrige-related presentations to deal with its problems.

"We believed in the Baldrige then and we believe in it now," asserts Wallace CEO Robert Vaughn, a former consultant who was assigned to the top spot by the majority-owning Wallace family earlier this year. "This company has had problems for 10 years, and we'd have been in reorganization long ago if it hadn't been for our TQM efforts." □

TQM reality check: It works, but it's not cheap or easy

Despite noisy criticism and difficult-to-measure results, most companies agree that quality improvements pay off

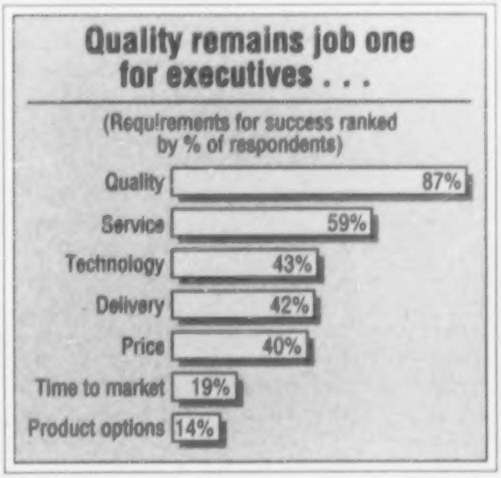
By Peter Burrows

QUALITY REALITY
CHECK

It's been more than a decade since Hewlett-Packard started the Total Quality Management (TQM) revolution by slamming U.S. chip makers for poor product quality relative to their Japanese competitors. The shock wave caused companies throughout the electronics industry to finally consider the long-spurned teachings of Deming, Juran, Taguchi, and others that had made the Japanese so successful.

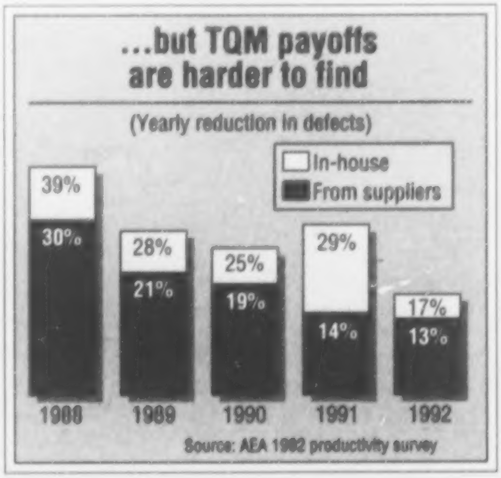
Ten years later, U.S. companies are still at it. From large computer makers in need of resuscitation to start-up companies who must prove their quality from the outset, TQM continues to gain steam as a way of doing business. "There's definitely a falling out occurring in this industry," says John Osborne, vice president of quality for semiconductor equipment maker LAM Research Corp. in Fremont, CA. "Certain companies are continuing to grow and gain share, and they are the ones that continue to invest in TQM. The others lose out as new priorities come up."

On balance, these TQM efforts seem to be paying off. No company contacted for this report had scrapped its TQM program, and 91% of 70 companies polled in an ELECTRONIC BUSINESS survey this summer said their quality has improved versus their competitors; 73% say their industry segment has improved versus the foreign competition. Even consumers have noticed the change. A survey done for the American Society of Quality Control by the Gallup Organization shows that 63% of consumers think that U.S. products



Quality remains job one for executives . . .

(Requirements for success ranked by % of respondents)



...but TQM payoffs are harder to find

(Yearly reduction in defects)

Source: AEA 1992 productivity survey

are better able to compete than five years ago.

That's not to say that America's quality revolution doesn't have critics. Indeed, many observers argue that U.S. industry's love affair with quality is fading. They cite the low number of applications for the Malcolm Baldrige National Quality Award, which fell to just 90 from 106 in 1991, and the reduced interest in quality-related events reported by the prestigious Conference Board and other business organizations. Moreover, a survey from the American Electronics Association shows that the percentage of U.S. companies with TQM programs in place has fallen from 86% to 75% since 1988—and that the rate of defect reduction per year has fallen from 39% to just 17% in that time.

Christopher Morrow

"Probably 95% of [TQM] programs fail, but no one has the guts to say so," charges industry veteran Luigi D'Angola, now a professional fellow at Dartmouth College

"There has been a tremendous amount of lip service, but the results have frankly been pathetic," says Jack Moore, a senior partner with and author of the survey for the consultancy Pittiglio Rabin Todd & McGrath (PRTM). Outside of the 9% that have reduced defects by 50% or more, most electronics companies normally only improve by about 5% to 10% per year, he says. "At that rate of improvement, most companies are *losing* ground to the market leaders."

Perhaps most damning, critics claim TQM has done little to boost U.S. competitiveness. Productivity growth of the U.S. manufacturing sector grew only 3.1% between 1985 and 1990, compared with 4.2% for the United Kingdom, and 4.3% for Japan, according to the Annual Index of Manufacturing Production from the U.S. Bureau of Labor Statistics.

"TQM is failing in an incredible way," charges Luigi D'Angola, an industry veteran who now teaches at Dartmouth College as a professional fellow. "Probably 95% of the programs fail, but no one has the guts to say so. It's too politically correct."

Maybe, but maybe not. Advocates of TQM, including ever-optimistic Baldrige program director Curt Reimann, say the criticisms completely miss the point. "Japan started its quality thrust around 1950, and it took them until the 1970s to be recognized as a quality leader," says Reimann. "Many of our companies have caught up in less than 10 years, so you have to keep things in perspective."

Indeed, it seems clear that the early revivalist-tent-meeting brand of TQM has matured into a more sophisticated and practical approach to business that is paying dividends. High-ranking executives have taken the reins from sloganeering consultants. Rather than naively dumping money into TQM training programs, companies are focusing on cost containment and ways to improve the efficiency of their quality programs. The academic focus of early efforts, as characterized by the fervent belief in the teachings of one particular guru, has given way to a focus on customer needs.

"There's always a lot of thrashing and churning when you get into TQM," says Cypress Semiconductor president T. J. Rodgers, who launched Cypress's program in 1985 in response to mounting customer complaints. "Now it's really starting to pay off."

According to the ELECTRONIC BUSINESS survey, U.S. commitment to quality is growing, not shrinking:

- Executives said they've planned to increase spending on quality-related training from 2.1% of revenues in 1991 to 3.9% this year;
- The percentage of companies who give quality training to upper management will rise from 66% in 1991 to 90% in 1992, and the number that give training to the top executive will rise from 56% to 83%;
- The percentage of companies using quality improvement measurement tools will rise from 40% to 76%.

Other indications of the rising commitment to quality are the regional TQM cooperatives that are springing up around the nation. In New England, for example, 33 companies now belong to the Center for Quality Management.

Companies with over 500 employees pay $10,000 per year ($5,000 for under 500 employees) to network and to access training courses and seminars. In the Northwest, five companies have forged the first of a series of Partnerships for Competitiveness set up by the AEA in which each company pays about $42,000 per year. The AEA plans to launch a partnership every six months or so.

"I've seen a lot of fads come and go, and I've not been a fan of most," says James Bixby, CEO of mixed-signal IC maker Brooktree Corp. in San Diego. "TQM simply makes good sense. It involves things that everyone in the

Motorola's quality crusade remains a model for the industry

MOTOROLA INC. may be electronic's best leading indicator of the TQM movement. Lambasted for poor quality in the early 1980s, the Schaumburg, IL-based company dove into TQM with a religious fervor never before seen in the U.S. electronics industry. A decade later, they're still at it. A 1988 winner of the prestigious Malcolm Baldrige National Quality Award, there seems little the company will not do in the name of quality:

- In 1988, it launched its now-famous Six Sigma campaign to reduce defect levels in all parts of the company to less than 3.4 per million opportunities;
- It spends lavishly to provide every employee with at least 40 hours of quality training per year. In 1991, Motorola spent 3.2% of total payroll in this effort;
- It has spent $70 million to create and run Motorola University, a TQM training organization with facilities on three continents;
- Executives have given over 1,700 speeches and presentations on TQM;
- The company has spent hundreds of thousands of dollars to create the Six Sigma Research Center, which it runs with Kodak, Texas Instruments, IBM, and Digital Equipment;
- Motorola runs an annual employee recognition contest of epic proportions. Last year, 30,000 Motorolans took part in the contest, which culminated with a week of presentations, dinners, and parties in Chicago for the 22 teams that made the finals.

TQM has cut Motorola's costs by $2.7 billion since '88, says VP Richard Buetow

When the Baldrige criteria began to take root as an effective framework for quality improvement in the late 1980s, the company worked to integrate it with its existing quality system. Motorola required week-long audits of all operations every two years. Now the company is integrating ISO 9000 into its already hybrid system.

"We're developing processes and procedures that meet the requirements of all three," says Jack Haslup, director of quality assurance and customer satisfaction for the computer group. When finished, the quality system—all 35 pages or so of it—will be put on-line so all employees can easily determine the accepted way to complete a given task. "Now that we have a single quality system, we're finding that there isn't a lot of unnecessary structure to bog down our TQM programs," says Haslup.

Has all this effort paid off? Motorola certainly thinks so. "The payback is so high that we usually don't bother to calculate it," says executive vice president and quality director Richard Buetow.

Buetow claims the $11 billion company has reduced costs by $2.7 billion since 1988, including $700 million in manufacturing costs alone. In the process, employee productivity has improved by 78%, even as the company grew 94%. Best of all, customers and competitors alike report that Motorola has closed the quality gap with Japanese rivals. Says Cypress Semiconductor president T. J. Rodgers, "Moto's quality has progressed to the point where most people can't tell the difference [from Japanese rivals]."

Buetow is especially proud of the 8.3% increase in headcount that has occurred in that time. "We sell computers and automotive electronics and defense systems—all industries that have had their share of lay-offs of late," he points out. "Not only did we save the 102,000 jobs we started with, but we've added 16,000 more." ☐

company can use if you just make it available to them." Once a shoot-from-the-hip technology company, Brooktree executives now take part in weekly quality meetings, and Bixby claims that all employees are members of quality-improvement teams. One result is a reduction in cycle time from 40 days to about four, Bixby says.

While he can't prove it, Bixby credits the TQM program for raising profits 40% through the first half of this year, compared with 11% revenue growth.

Critics claim TQM has done little to boost U.S. competitiveness

The question remains, however, as to why more U.S. companies are not doing better with TQM. The four-year slide in defect reduction rates in the AEA study, which has tracked over 400 companies for 5 years, is certainly discouraging. "We're at a loss to explain it," says PRTM's Moore. "The industry seems to be getting smarter about TQM, but the surveys simply don't show it."

One possibility is that the industry at large is just getting to the point of bottom-line benefit with its TQM efforts. After years of work to put quality systems in place, many companies are for the first time focusing on results rather than on training employees and benchmarking competitors. They are progressing to the next phase in which TQM is used to directly tackle customer complaints—and thereby win market share.

Take the example of Varian Associates Inc., the Palo Alto-based IC production equipment maker. The company had realized impressive operational quality improvements at many of its units but got no identifiable bottom-line

Making TQM work in times of trouble

ONE OF THE CORE tenets of Total Quality Management (TQM) is employee involvement and teamwork—but how can the necessary trust and morale be maintained at companies in the throes of downsizing?

Take AIL Systems Corp. of Deer Park, NY. In 1984, the company had grown to $800 million per year with 6,000 employees on the strength of Air Force contracts to build defensive systems for the B-1 bomber. Since then, defense cuts prompted relentless downsizing, to $272 million and 1,600 employees.

Surprisingly, the corporate trauma has not deep-sixed the TQM effort launched by management in 1989. In fact, it seems to have done just the opposite. "We know we have to do things better, or we simply won't survive," says Tom O'Brien, who now works with seven others in a stockroom that used to be crowded with 40 workers. "That's the era we're in, and we have to live with it." Sprinkling his speech with TQM-speak, O'Brien talks enthusiastically of training courses and of his participation in a cross-functional team to cut procurement times.

This phenomenon seems to be common in the electronics industry. Even as large computer makers such as IBM and Unisys struggle to make massive strategic shifts, they report impressive operational improvements and stable employee morale levels. "Had it not been for the quality practices we had in place, we would have had a much tougher time maintaining morale," says George Ballata, a longtime manager at Minneapolis-based Control Data Corp., who has himself taken an early retirement package after the company scrapped its hardware business earlier this year.

Management must carefully direct the introduction and maintenance of TQM programs, however. Many employees at AIL, for example, saw TQM as a threat to their jobs when it was first introduced, and controversies still flare over expenditures for off-site quality meetings and the $100,000-plus that was spent to apply for a New York State quality award last year.

Quality assurance director Charlie Decker says that frankness, empowerment, and recognition are the best means to get employee buy-in. The company has implemented an employee suggestion program and has put 437 of the 767 suggestions made so far into action. Expected lay-offs are announced well in advance whenever possible. "Employees cannot tolerate uncertainty," says consultant and industry veteran George Ebel. "TQM can do well when times are bad if you have enlightened management, but it cannot survive a constant onslaught of change." His advice: Make lay-offs deep enough to last. ☐

benefit. One unit improved on-time delivery from 42% to 92% and reduced warranty costs from 15% to 6%, but it saw market share shrink. A components division cut scrap by 400% but profits dropped. A systems business reduced cycle time dramatically but watched inventory increase.

To some extent, the mystery has since been explained, says executive vice president Richard M. Levy. Since incoming CEO Tracy O'Rourke refocused the TQM effort on customer complaints when he joined Varian in February 1990, he found that poor voice-mail habits, slow service, and hard-to-use software were limiting sales growth, regardless of improved product quality, on-time delivery, and cycle time.

"I've seen a lot of fads come and go, but TQM simply makes good sense," says Brooktree CEO James Bixby

"Blind adherence to a given process can easily cause a manager to overlook the changing priorities of customers," says Levy. "Customizing the process can, and has, resulted in a vital business system that energizes employees and contributes to success."

Other companies have survived similar missteps and are now seeing the signs of a mature quality-based corporate culture taking root. "When you first get in to TQM, the religion tends to take over for common sense, and employees sense that in a nanosecond," says Cypress's T. J. Rodgers.

Rather than a pasture for long-in-the-tooth lifers, the quality director's office is being filled more and more with up-and-comers

The improving status of the much maligned title of quality director is also an indication that quality is being taken more seriously. Rather than a pasture for long-in-the-tooth lifers, the quality director's office is being filled more and more with up-and-comers. When IBM chairman John Akers gave a top quality post to Lawrence Osterwise, who managed Big Blue's minicomputer operation in Rochester, MN, to a Baldrige in 1990, "it was a clear statement that commitment to quality is a way to get ahead," says one IBMer.

Similarly, Cypress's Rodgers chose former top product line manager Jeff Kaszubinski to be his vice president of quality and reliability assurance. "He was right where he wanted to be as head of the EPROM group, but I asked him to step down," says Rodgers. "He could contribute more to the company from the quality office, and I made it worth his while to do so."

Rodgers goes so far as to hint that the top quality job is a likely jumping-off spot for the presidency of the company. "I don't see how anyone could succeed me who hadn't been the vice president of quality or manager of a major business that demonstrated quality leadership that others were trying to emulate," he claims.

Yet another sign of the maturing of TQM is the increasing focus on the cost side of the equation. From the days when early adopters threw money at TQM on the strength of consultant Philip Crosby's "Quality is Free" mantra, companies now recognize—and look to closely manage—their TQM-related dollars. "Companies used to pay some education firm millions of dollars and then tell their employees to 'go forth and make quality,' " says PRTM's Moore. "The result was a lot of small 5%-to-10% improvements, but nothing major."

That attitude is starting to be rethought by quality leaders. IBM, for example, is working to reduce the percentage of payroll spent on training—a level that reached as high as 5% at the Baldrige-winning unit in Rochester, MN.

"We have a huge college catalog of courses, but that wasn't giving our people a consistent set of information on a core of topics in a reasonable amount of time," says Osterwise. "We would have managers taking leadership courses with 25 other people and getting all charged up, only to find that no one knew what they were talking about when they got back to the office."

To make sure the course work takes hold, the Rochester unit now converts its cafeteria into a classroom for a day-and-a-half each year during which time every employee gets a 90-minute basic-training session, starting with managers at 7:00 A.M. on the first day. "It may not sound it, but this saves us money in the long run." □

What is return on quality, and why you should care

Cost of quality calculations often show huge payoffs, but "return on quality," or ROQ, may be a concept ahead of its time

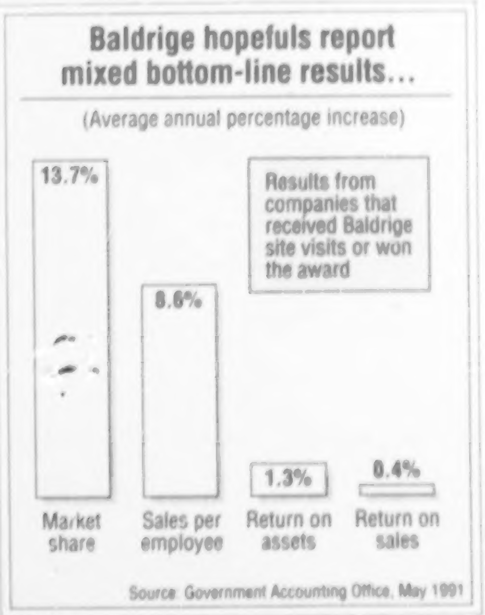
By E. B. Baatz

RETURN ON QUALITY

Quality improvements can pay off big, but proving it and monitoring it in ways that will satisfy numbers-driven CEOs and their Wall Street backers is another challenge altogether. For starters, there is considerable confusion about what return on quality, or ROQ, actually is.

Tracking down the immediate payoff from reducing defects, waste, and customer returns is a fairly straightforward process. Eliminating these costs—typically called the "costs of poor quality"—gives a fast boost to the bottom line, and it's a number that's easy to calculate. Yet return on quality—the price premium that a company gets on its product for its investment in quality—is a much more comprehensive concept. Many executives complain, and rightfully so, that it is a hard number to pin down.

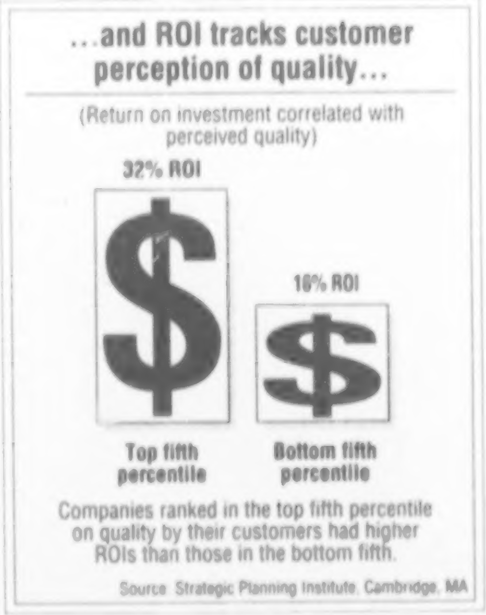
Critics suggest that those executives who worry most about profitability are the ones stalled in their total quality management (TQM) program. It's helpful, though, to draw the distinction between those companies in the initial



Baldrige hopefuls report mixed bottom-line results...

(Average annual percentage increase)

Source: Government Accounting Office, May 1991



...and ROI tracks customer perception of quality...

(Return on investment correlated with perceived quality)

Companies ranked in the top fifth percentile on quality by their customers had higher ROIs than those in the bottom fifth.

Source: Strategic Planning Institute, Cambridge, MA stages of reaping cost-of-quality benefits, when the savings are big and everyone is euphoric, and companies in the later stages of continuous improvement, when quality has become a strategic advantage. For those in the latter stage, the quality-to-profits ratio is still a black hole.

IT'S SIMPLE to rationalize spending on quality in the beginning. Chances are, many electronics execs who have recently turned their skills to quality management have shared the experience of Matt Bergeron, chief financial officer for board maker Praegitzer Industries Inc. in Dallas, OR. One day, CEO Bob Praegitzer came into Bergeron's office and asked him to justify the company's quality investments.

"We spend one hell of a lot of money on quality, and that's why he asked the question," says Bergeron. He examined the inverse relationship between gross profits and money spent on quality. Bergeron's conclusion: There was a clear, definite payback. He found, for example, a six-times return from the company's spending on training.

Pioneers on the subject such as H. James Harrington, author and quality adviser for Ernst & Young in San Jose, have long ago concluded the returns from reducing the costs associated with poor quality can be substantial. Harrington estimates the cost of poor quality exceeds 10% of sales for electronics companies; for manufacturing companies in general, he calculates those costs average between 20% to 30% of sales; and for service organizations, the costs run a staggering 30% to 50% on average. When these costs are eliminated, the return can be dramatic. "It's very common that a company can save more money by cutting poor-quality costs in half than it can make by doubling sales," says Harrington.

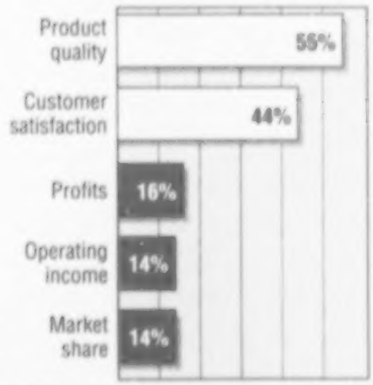
What's surprising, though, is how few companies actually keep track of the cost of quality. In May 1991, the Government Accounting Office (GAO) released a study of 22 companies that had made it into the final round of the Malcolm Baldrige National Quality Award competition. The GAO found only five companies had measured the cost of quality. Another study done in 1989 by the American Electronics Association in conjunction with the Weston, MA, consulting firm of Pittiglio Rabin Todd & McGrath showed only 40% of those surveyed had calculated their cost of quality.

Why don't more companies do the math? The companies studied by the GAO cited the problems inherent in defining the sometimes subjective cost factors and the administrative burden of collecting the data. Furthermore, when the returns to the bottom line are so big and so dramatic, some figure, why bother to stop and calculate it? "These are no-brainers," says Richard M. Levy, executive vice president of Varian Associates Inc. in Palo Alto, CA. "If you're doing it right, you're getting payoffs every day."

YET, IT IS possible to spend too much on quality programs. "You make a big mistake if the improvement process doesn't pay back in the first year. There are over 150

...but execs don't rate profits high among benefits...

(Primary benefits of quality programs as rated by % of respondents)

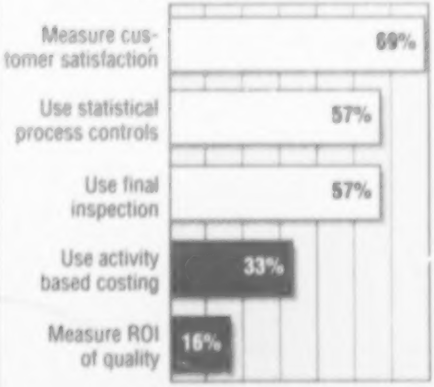


Multiple responses allowed

Source: ELECTRONIC BUSINESS 1992 quality survey

...and few electronics execs measure "return on quality" now

(% of respondents who have taken the following actions)



Multiple responses allowed

Source: ELECTRONIC BUSINESS 1992 quality survey

Cindy Charles

"**I think you** can invest too much in quality. There are always marginal dollars to look at"

Matt Bergeron
CFO, Praegitzer Industries Inc.

different improvement tools now, and CEOs need to look at which ones will deliver the biggest profits," says Ernst & Young's Harrington. "I think you can invest too much in quality. There are always marginal dollars to look at," agrees finance officer Bergeron. Spending more money to reduce defects, says Bergeron, may not give you an adequate payback because if you're already a leader in your product area, no customer is going to pay you extra for the money spent on quality. This, of course, begs the questions: How much is too much? And to determine that, should companies be figuring out how to measure ROQ?

Particularly for companies in the latter continuous improvement stage of a quality program, the answers to those questions aren't easy because ROQ is more than simply calculating the cost of quality. ROQ should also measure the returns that come from investing in quality over time—not just from reducing defects. "The evidence is clear on company case studies of cost savings," says Bradley T. Gale of Boston-based consulting company Market Driven Quality Inc. "In terms of whether increased quality means [being able to obtain] price premiums, the evidence is still not in."

Indeed, high-tech executives and quality consultants who have grappled with the need to calculate ROQ fall among a spectrum in an emerging debate about it. At one end are those who take it on faith that quality works. These executives waste little in worry or effort trying to measure quality's benefits.

At the other end of the spectrum are those still looking for effective measurement techniques beyond cost of quality. They continue to plow more and more money into TQM programs while they search for better formulas to prove TQM's worth.

At Motorola, quality comes first and profits are just expected to follow. "I have a problem with anyone who asks for a cost/benefit analysis," says Jack Haslup, director of quality assurance and customer satisfaction for Motorola's computer group in Tempe, AZ. "We don't allow defects to be characterized as minor or major. They all must be eliminated [because] we simply can't afford to have poor quality."

Listen to Jim Oehrlein, manager of Motorola's corporate financial reporting group in

"**I have a problem** with anyone who asks for a cost/benefit analysis"

Jack Haslup
Director of quality assurance
Motorola Inc.'s computer group

Schaumburg, Il., describe his department's quality drive. "It was more important in our case to identify cycle time and process improvements. Direct cost savings were a secondary consideration." That the group saved $233,000 in its first year as a result of streamlining the quarterly financial reporting process was not Oehrlein's primary goal.

The debate surrounding ROQ isn't black and white. "I think [ROQ] is a good question, but in some ways, it falls into what [quality expert] Dr. Deming calls the unknown and unknowable," says Tom Ashburn, general manager of the worldwide support materials operation for Hewlett-Packard Co. in Roseville, CA. Still, Ashburn warns, "you can spend money on things that relate to quality for which there is no payback. So while you can't get your arms around all the financial aspects of quality, you have to be constantly testing to make sure the spending makes sense."

Ashburn's group has been implementing TQM for 10 years, and he recalls spending too much time and money in the early days. He says he trained people too soon and didn't give his team a solid business framework in which to implement process improvements. Now he requires a rigorous application of something he calls "business fundamental tables" where profits, customer satisfaction indexes, and inventory levels are closely monitored every month.

Likewise, at IBM's Rochester, MN, plant, the trick now has been to integrate a concept which Roy Bauer, director of quality, calls the "quality payback formula." As well as the tan-

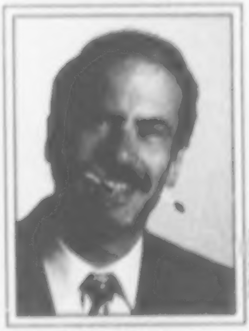
Customer-supplier quality program nets $4.8 million

THE TRICKLE-DOWN economic theory may be out of favor these days, but trickle down in the quality arena still has a lot of punch left. Take the case of a customer-supplier partnership between two Silicon Valley companies, local area network supplier SynOptics Communications Inc. and printed circuit board (PCB) maker Sigma Circuits Inc. Partly as a result of their *interdependent* quality programs, the two have delivered some impressive numbers—their joint savings totaled $4.8 million last year, about 1.7% of their combined annual revenues.

Eighteen-year-old Sigma Circuits, a privately owned company with about $30 million to $40 million in annual revenue, began its total quality management program just two years ago and its partnership with customer SynOptics a year later. The company's regional sales manager, Scott Steward, figures the cost calculations are less important than the fact that "if we hadn't had the TQM program, SynOptics would not have picked us." Nonetheless, the synergy of the relationship has more than paid off in reduced defects—which have fallen 30% over a 14 month period, says former president Jim Barton.

As for SynOptics, founded in 1985 and already over $248 million in revenue, non-value-added inspection has been reduced by 40% over the last 18 months and the company calculates its supplier programs alone have saved at least $2.5 million in cost of goods sold. The company has always kept a close eye on costs. "We collect component failure data and do a cost analysis on the top 10," says Dennis Omanoff, quality director for SynOptics. "Most large suppliers are surprised when we tell them not only the defect rate per million, but also the cost to us each month."

A key to SynOptics's cost-savings drive has been to get its suppliers to plan new products together. For example, SynOptics brings its volume PCB supplier, Zycon Corp., and its niche supplier, Sigma Circuits, into the same room to make sure the two companies iron out possible manufacturing glitches early on in the planning stage. ☐



Not only do we tell suppliers their defect rate per million, but also the cost to us, says SynOptics's Omanoff

The synergy of the relationship has more than paid off in reduced defects, says Sigma Circuits' Jim Barton

gible quality metrics such as scrap, inventory carrying costs, and cycle time, Bauer's division maps its spending relative to five bottom-line measurements: profits, customer installed base, customer satisfaction, revenue growth, and market share. While profits are confidential for the division, the other four concepts rose 34%, 9%, 38%, and 18%, respectively, from 1988 to 1991. "Our quality initiative at Rochester has been that if what you're doing doesn't translate to the bottom line, then you have to rethink your priorities," says Bauer.

The debate remains a noisy one. "Implicit in this question is the fact that that executives should be concerned with the relationship between profitability and quality," says Carl Thor, former vice chairman of the American Productivity & Quality Center in Houston, TX. "I'm not sure that's necessarily true. Managers trying to prove the unprovable will end up with bad results."

Nonetheless, the research goes on. For example, there's a new, massive joint project between the American Quality Foundation (AQF) and Ernst & Young to try to quantify the causal relationship between quality investments and profits. Josh Hammond, president of AQF in New York City, contends that models linking quality and profits *must* be tested so executives can develop better maps with which to direct their quality initiatives.

Concrete results were not available at press time, but Hammond's report, *The Best Practices Report on International Quality*, is expected to be released this month. "It is going to make quality consultants uncomfortable, but it will give executives a way to focus their efforts and set priorities in their quality programs," claims Hammond.

Perhaps a revolution is underway in how companies measure their business performance. During revolutions—even the total quality management one—fights break out and communication breaks down. For now, anyway, the language of quality is certainly not the language of Wall Street. □

ABC management can help increase quality savings

ONE OF THE accounting revolutions taking hold among quality-driven electronics companies is something called activity-based costing (ABC). Traditional accounting methods assign manufacturing costs to products based on the product's labor content. ABC requires that managers look closely at *all* the activities a particular product actually consumes, including direct labor content, spare parts usage, or time spent setting up machinery.

Consider this oft cited example. In a paint-spraying part of an automobile assembly line, the cost of running the machinery is typically split equally among the number of cars sprayed. When the factory sprays six cars blue, then three red, and only one yellow, the spray guns are changed three times. Under ABC, that single yellow car actually carries the burden for fully one-third of the extra expense to change the guns. Thus, the blue cars cost less to manufacture than the lone yellow car.

Varian Associates Inc. is one of many high-tech companies now experimenting with ABC. By distinguishing between indirect activities that add value and those that don't, the company's strategic decision-making is now more sophisticated, says Richard M. Levy, executive vice president for Varian. "In the instruments division, for example," says Levy, "we realized one product line, which was a smaller portion of our business, actually contributed more to profits and that changed our strategy."

This may sound easy, but it's not. ABC is not about developing a more accurate way to allocate costs. It is about analyzing the resources needed to make products in order to make better management decisions about how to grow profits, explain professors Robert Kaplan and Robin Cooper of Harvard Business School, the acclaimed experts on the subject. For executives who have already adopted the continuous improvement philosophy, ABC helps explain how and why those management changes can be so profitable.

"Quality purists don't like ABC," says consultant Carl Thor. "I'm overstating perhaps, but the only thing that counts to them is physical, not financial, data." ABC, however, may just be the tool to help bridge the gap between the language of quality and the spreadsheets of finance. At the very least, adds Tom Ashburn of Hewlett-Packard Co., ABC does help you to "sharpen your pencil."

For more information about ABC, see Kaplan's and Cooper's book *The Design of Cost Management Systems* (Prentice-Hall, 1991). For how-to seminars on ABC, call the American Productivity & Quality Center at (800) 776-9676. □

Industry to B schools: Smarten up on TQM or else

Companies say business schools better get quality into their curricula or their graduates won't get work

By Barbara Jorgensen

EDUCATION

Howard Wilson is unhappy with the quality of some of his purchased goods lately. "Supplier quality is imperative to the success of our own quality efforts," says Wilson, director of market-driven quality for IBM. "If we have to inspect and retrofit even *some* of our suppliers' parts, it's expensive, and our products [become less than] world class."

Wilson isn't talking about microprocessors or cable assemblies, but about the hundreds of new MBAs that Big Blue must retrain every year because so many American business schools pay little more than lip service to the principles of total quality management, or TQM. As a result, says Wilson, IBM—a 1990 winner of the Malcolm Baldrige National Quality Award—coughs up more than $1 billion annually for worker training.

Things aren't much better at Motorola, which now spends an estimated $70 million annually on employee training—half of it quality-related. "We've found graduates who are unable to work as part of cross-functional teams," complains Motorola's Jim Robertson, manager of instructional development for quality. Students also are poorly trained in concurrent engineering and design for manufacturability, he says, and are often unaware of the practical ways in which design impacts product cost.

There's plenty of blame to go around. Executives admit they haven't always communicated their quality requirements to the nation's business schools, even though many companies—including IBM, Motorola, and Xerox—are well-equipped through experience to impress schools with the need for TQM methods.

That's changing. More and more companies are sending business schools the message that MBAs who are not trained in TQM may be passed over for recruitment.

"You have to create a crisis," says Wilson, recalling IBM's own market-share crisis that pushed the company into TQM. "We're telling colleges and universities that students should be coming to us with TQM concepts ingrained."

To help reach that goal, industry is increasingly reaching out to schools to drive home the need for TQM in the classroom. Reams of academic applicants, for example, have signed up for an IBM grant program and for the so-called TQM University Challenge (see "Industry pitches in to bring quality to the classroom").

Although joint company/university TQM programs have been directed mainly at graduate schools, long-term plans call for teaching quality techniques at the undergrad, vocational, and K-12 level as well. "Most of the people we hire for the manufacturing line don't have college degrees," says IBM's Wilson. "But they have to accept the mindset of TQM just as much as an MBA."

AT LEAST SOME schools are getting the message. "Since we're suppliers to corporations, we need to provide them with what they want," says professor Ash Rao at Babson College in Wellesley, MA.

The results so far have been promising, though hardly revolutionary. At the very least, industry is beginning to make some converts among the academic rank and file. Recalling his participation in a Xerox-sponsored TQM program, Don Hale, public-relations administrator at Carnegie-Mellon University in Pittsburgh, admits "I was a skeptic. This thing had a faddish side." What changed his mind was watching Xerox personnel work among themselves and with Hale's group. "It impressed the hell out of me," he says.

To be fair, many U.S. business schools have come a long way in the past few years. Academic and industry sources claim that exceptional TQM curricula are offered by the universities of Chicago, Tennessee, Miami, New Mexico, Maryland, and Illinois, as well as by Oregon State, Fordham, MIT, and Columbia. Overall, though, the news at 1991's Total Quality Forum in Cincinnati wasn't good: Fewer than 5%—and perhaps as little as 1%—of about 600 U.S. business schools have been affected by the quality revolution that is driving change in U.S. and worldwide businesses, said keynote speaker Robert Kaplan, a professor in Harvard University's Graduate School of Business Administration (see "Quality gets short shrift at top U.S. business schools").

One problem is that universities encourage individual performance rather than teamwork

That helps explain industry's concerted push to integrate quality into colleges. In too many quality-driven organizations, says Maria Huang, customer-driven quality director at S-MOS Systems in San Jose, managers must "unteach" what MBAs are taught in school—to be in charge, to be in control, and to be sole decision-makers. Executives argue that the responsibility (not to mention some of the cost) of training the next pool of labor in TQM should shift from the corporation to the campus.

Why has TQM been so slow to migrate from industry to the campus? One reason: Like Carnegie-Mellon's Hale, many academics still see TQM as a fad or buzzword. And since quality isn't usually considered a research topic, few incentives exist for staff to pursue it as a discipline. TQM's cross-functional nature also works against its acceptance, since the university environment encourages individual, rather than group, performance. When S-MOS Systems' Huang pursued her master's degree, for example, she steered away from an MBA. "[Management] schools teach you to organize, but they also teach you to control," she says. "In quality, you have

How your company can make a difference

GIANTS such as Motorola and IBM are powerful enough to influence how quality is taught in universities, but most electronics companies earn less than $100 million in revenue. Yet even the smallest company can influence the adoption of quality practices in the nation's schools, says Eve Majure, senior manager of university programs for the American Electronics Association (AEA):

- Invite a faculty member to one of your company's TQM courses;
- "Adopt" a faculty member and start a mentor program based on continuous exposure to TQM principles;
- Encourage management to make the faculty/mentor relationship part of employee responsibility, not something to be done on workers' own time;
- Encourage your CEO to partner with other top execs and visit a local university president, as former Xerox CEO David Kearns did with the University of Maryland. TQM integration, notes Majure, is only as good as the commitment at the top;
- Encourage engineering and business schools to work on cross-functional TQM together. IBM's grant program specifies joint business/engineering projects as a condition of the award;
- Encourage a system that awards tenure based on TQM implemented in courses and in the organization;
- Work with universities that commit to integrating TQM as a required course;
- Help to design and critique course plans;
- Make it clear to college employment liaisons that a background in TQM will be mandatory if their graduates are to be hired;
- Notify schools that they and their graduates will be assessed on the basis of their commitment to quality;
- Emphasize that research grants will be awarded on the same basis.

Majure notes that the AEA has been working with the industry since 1981 to improve engineering education through foundations, grants, and fellowships for students and faculty at all levels. □

to let go of control and learn to empower employees."

The teaching of quality also proves confounding. "The problem with TQM is that you can't pull out a book and teach it—it's a philosophy," says Tom Brady, assistant director at the Center for the Management of Manufacturing Enterprises at Purdue University in West Lafayette, IN, which is implementing a TQM curriculum with Motorola's help. "Going to Motorola was a good experience, but not everyone's convinced that what's good for Motorola is good for Ford and so on. It's tough to agree on just what to teach."

In contrast to most companies, TQM implementation even differs within a given university. Indeed, engineering and business schools often teach TQM in their own vertical "silos," neglecting the cross-functional training that is at the heart of TQM. James Bonini, a graduate of MIT's Leaders for Manufacturing program in Cambridge, points out that the

Industry pitches in to bring quality to the classroom

SEVERAL U.S. corporations are working with the nation's universities and grade schools to teach and implement TQM. In August 1991, for example, former Motorola chairman Robert Galvin issued the TQM University Challenge at the annual Total Quality Forum, hosted by Procter & Gamble in Cincinnati.

The challenge urged universities to integrate TQM principles into their curricula and their own operations, with the help of 5 participating companies. Motorola was matched up with Purdue University, Procter & Gamble with the University of Wisconsin at Madison and Tuskegee University, Xerox with Carnegie-Mellon University, Milliken with North Carolina State University and the Georgia Institute of Technology, and IBM with MIT and Rochester Institute of Technology.

The challenge required that the college conduct an internal quality assessment, much like the Baldrige; that it perform a "customer survey" to determine who its customers are, how to survey them, then gear itself toward customer service; and, by June 1993, that it develop a TQM curriculum integration plan to be implemented by September 1993.

Each company sponsored a week of onsite education for engineering, business, and administrative personnel from its university match. Costs were covered by the companies. These were completed in the spring, and universities now are forming internal steering committees and following up with their corporate partners.

Robert Sullivan, dean of Carnegie-Mellon's Graduate School of Industrial Administration, attended Xerox's program, which was modified to apply to a university. TQM was already being taught, says Sullivan, and the university was looking for a way to include TQM across-the-board. "We got some good ideas for the curriculum," he says, "but we also found out how to effect things outside the classroom." Orientation for incoming graduate students, for example, now includes problem solving and interactive projects. By applying TQM principles throughout the university as well as in the classroom, Sullivan believes TQM will be constantly reinforced.

Out of the TQM University Challenge sprang a number of subcommittees, one of which is the Employers' Needs Working Council. The council's charter is to gauge TQM needs and expectations throughout all areas of employment—industry, government, health, services, and manufacturing. The committee, comprised of CEOs and university heads, will try to assess what employers want from graduates. A report will be issued at the next TQM Forum, hosted by Procter & Gamble, in November.

Another industry-university effort is a $1 million grant from Florida Power & Light (the first U.S. Deming Award winner) to the University of Miami to set up a TQM program; the university formed the Institute for the Study of Quality in Manufacturing. The school now offers TQM education modules, incorporated into seven business and engineering courses, that apply TQM principles to the topic being studied. The university also has been researching the need for a TQM master's degree program.

Finally, IBM's TQM Competition will award either $1 million in cash or $3 million in equipment to eight universities who demonstrate TQM integration across disciplines; accelerated research on quality; plans to implement TQM concepts in administration and operations; institutional commitment for funding, personnel and outside support, and propagation/sharing with other colleges and universities. ☐

program—which applies TQM to its own operations as well as teaching it—differs from the rest of MIT's Sloan School of Management. "TQM means we need a cross-functional mindset," he says. "Instead, the mindset is 'divide and conquer.' "

Engineering schools, for example, teach such TQM tools as statistical process control (SPC), quality function deployment (QFD), and shop-floor quality methods. But such tools don't change a company's culture, says Dartmouth College professor Luigi D'Angola, they only improve methodology.

Management schools, meanwhile, need to examine accounting systems such as activity-based costing to permit cross-functional design work and to trace the impact of design decisions, says Motorola's Robertson.

Cindy Charles

"We take math and composition [among graduates] for granted," says Sun Microsystems' Jim Lynch. "The same should be true for quality"

Just what does business want from the schools? For starters, says IBM's Wilson, TQM must be part of required, not elective, course work. Jim Lynch, director, strategic planning and quality deployment for Sun Microsystems Inc., and chairman of the American Electronics Association's National Total Quality Commitment Committee, says TQM should be as pervasive as other basic skills.

"We take math and composition for granted at Sun," says Lynch. "The same should be true for quality. My fear is that with the 50-year head start the Japanese have on quality, they'll find a way to make it pervasive through their culture as well as through their companies."

Moreover, Lynch adds, the new MBA should be a generalist, not a specialist. Since quality is increasingly customer-centered, employees must possess a set of four basic skills:

- Listening to the customer, then quantifying, developing, designing, and delivering to the customer's specifications;
- "Management by fact"—i.e., management based on decisions driven by analytical, objective methods;
- The ability to work effectively in a cross-organizational approach rather than in vertical engineering or management silos;
- Adaptability to change in mindset, skills, and traditional management roles.

Quality gets short shrift at top U.S. business schools

(Ranked best to worst, school year '90-91)

No. of schools	Course data
1	3 to 4 weeks of a 10-week course are devoted to quality
1	5 of 20 sessions cover quality
1	6 of 42 sessions devoted to quality
1	Multiple electives on quality offered
12	1 elective on quality management offered
15	3 or fewer sessions spent on quality; courses run 13 to 28 sessions

19 responses, data above overlaps

Source: Robert Kaplan, Harvard University

COLLEGES AND universities are heeding these calls for TQM for the same reason business did almost a decade ago: competition. "You need [TQM programs] to gain credibility, especially if a company like Motorola is saying 'we won't hire your students,' " says Purdue's Brady. "That matters to us. And if students see that, they won't enroll here."

Nathan Stuart, a graduate of MIT's Leaders program, says the TQM skills he learned there were "a significant plus, a skill worth promoting" when he was being recruited by his current employer, Eli Lilly.

Ultimately, say the optimists, these efforts could lead to the development of the "American way" in TQM, not an imitation of the Japanese. "There's an enormous amount of good stuff being done in the U.S.," says Dartmouth's D'Angola. "It's possible that someday we could leapfrog the Japanese." □

TOP 50 ASIAN ELECTRONICS COMPANIES いちばん 50

Recession walloped Asia's electronics industry too

The downturn in Japan slashed net income at top Asian companies by 24% in '91. This year's sales are expected to remain flat

By Paula Doe

About the best that can be said about Asian electronics companies in 1991 is that they fared better than their U.S. counterparts.

Thanks to a healthy first half, before the recession hit Japan and the rest of the Far East, total electronics sales by the top 50 Asian companies grew by 4%; sales by the top 50 U.S. electronics companies remained essentially flat. But the downturn in the second half of 1991 sent Asian net income plunging 24% for the year—not nearly as bad as the 59% earnings freefall at the U.S. top 50, but enough to trim Asian margins to the same slim 2% for the top U.S. companies. The outlook for Asian electronics in '92: no more damage, probably, but nothing that looks like a recovery, either.

Even in a bad year, Asia tops U.S. in electronics

	Asia's top 50		U.S.'s top 50	
	$ billions*	% change '90-'91**	$ billions*	% change '90-'91**
Electronics sales	$322.3	4.2%	$295.1	0.3%
Total sales	623.2	4.9	670.9	-2.8
Net income	13.7	-23.7	12.8	-59.1

*$1=Y133/733 Korean won
**Measured in local currency

How the top 50 measure up

	Asia	U.S.
Net income/sales	2.2%	1.9%
Return on equity	3.6	6.1
Return on investment	1.9	4.5
Debt/total capital	47.9	31.0
Foreign sales/total sales	41.0	35.0

Source ELECTRONIC BUSINESS

The story of the top Asian electronics companies is the story of Japanese electronics; indeed, ranking top Asian companies shows how thoroughly Japan still dominates the industry in the Far East. Hong Kong-based *Electronic Business Asia* reports that total electronics sales by the 50 top Asian non-Japanese electronics companies come to a mere $26 billion. When Japanese companies are included, the total for the 50 top Asian companies is $322 billion.

The only non-Japanese companies big enough to make the $1 billion or so cutoff for this year's list are the four Korean conglomerates—Samsung Electronics, Goldstar Co., Daewoo Electronics, and Samsung Electron Devices, all of which bucked the Japanese downturn to turn in hefty growth rates. Taiwan's Acer Inc., with sales of $981 million, and Tatung Co., at $794 million, also came close to making this year's top 50.

The story in Japan was grim. Exports were hit by the high yen and the U.S. recession. The collapse of the bubble economy in Japan forced companies to slow their investments in computers and equipment and consumers to cut spending on electronic gadgets. Demand collapsed in the fall of 1991, leaving companies with six dismal months before they closed their books in March.

Many leading companies saw their profit margins plunge even further than the top 50's total 21% drop in operating income. Things were so bad in the second half of the year that, in spite of the relatively healthy first half, a host of leading companies saw their 1991 operating incomes plummet more than 40%. NEC Corp., for example, suffered a 43% decline. Others include Toshiba Corp. (-55%), Sony Corp. (-44%), Ricoh Co. (-68%), and Oki Electric (-66%).

A few companies did well. Nintendo Co. maintained 19% growth in sales and jumped 26% in net income as it kept the video-game business going strong for yet another year. Casio Computer Co. saw a 14% increase in sales and a 15% improvement in net income, thanks to strong sales of electronic musical instruments and office equipment. Ceramics maker Murata Manufacturing Co. managed net margins of 9.7%. And Fujitsu Ltd. saw a big 16% sales growth thanks to strong computer sales, though its net income plummeted a whopping 85%. ☐

TOP 50 ASIAN ELECTRONICS COMPANIES

いちばん 50

Rank 1991	Rank 1990	Company	Electronics sales ($ millions)	% change (90/91)	Total sales ($ millions)	% change (90/91)	Operating income ($ millions)	% change (90/91)
1	1	**Matsushita**	$36,638	4	$56,014	13	$2,925	-18
2	2	**NEC**	28,375	2	28,375	2	913	-43
3	3	**Toshiba**	26,602	0	35,507	1	891	-55
4	5	**Fujitsu**	25,879	16	25,879	16	988	-33
5	4	**Hitachi**	25,169	4	58,388	0	2,647	-30
6	6	**Sony**	22,959	6	28,734	6	1,250	-44
	7	**NTT**	16,379	3	48,108	2	4,274	-9
8	8	**Canon**	13,771	8	14,052	8	1,038	-13
9	9	**Mitsubishi Electric**	12,510	0	25,137	1	1,103	-30
10	10	**Sharp**	9,704	0	11,691	1	463	-19
11	–	**Samsung Electronics**	7,131	16	7,131	16	907	56
12	11	**Ricoh**	6,655	1	7,650	1	84	-68
13	12	**Sanyo**	6,060	7	11,933	8	372	2
14	13	**Oki Electric**	5,122	3	5,122	3	76	-66
15	–	**Goldstar**	5,025	23	5,025	23	460	18
16	14	**Pioneer**	4,609	2	4,609	2	433	-20
17	16	**Nintendo**	4,224	19	4,224	19	1,109	7
18	15	**TDK**	4,022	-1	4,022	-1	406	-21
19	19	**Omron**	3,633	4	3,633	4	188	-45
20	17	**Alps**	3,469	0	3,469	0	142	-21
21	18	**Nippondenso**	3,397	-2	11,138	-2	495	-39
22	20	**Toyota**	2,964	NA	74,099	7	3,758	-22
23	21	**Kyocera**	2,959	-3	3,410	-2	318	-24
24	24	**Casio**	2,883	14	2,883	14	158	13
25	22	**Citizen**	2,757	0	3,100	1	213	-22
26	26	**Seiko****	2,446	0	3,218	0	118	-32
27	25	**Minolta**	2,356	-4	2,678	-4	-26	NM
28	28	**Murata**	2,109	1	2,109	1	335	-1
29	23	**Fuji Electric**	2,074	4	6,837	8	315	2
30	31	**Nissan**	1,850	NM	48,255	8	1,102	16
31	32	**Kenwood**	1,821	10	1,821	10	68	16
32	34	**Ryosan**	1,693	7	1,693	7	60	40
33	33	**Konica***	1,678	4	4,195	4	192	-6
34	35	**Japan Radio**	1,630	5	1,630	5	116	-12
35	29	**Nikon**	1,618	-10	2,048	-11	98	-59
36	37	**Olympus**	1,565	5	1,956	5	104	-45
37	41	**Rohm**	1,541	8	1,541	8	172	101
38	27	**Matsushita Electronic Works**	1,541	1	8,104	5	703	0
39	38	**TEL**	1,483	NM	1,483	NM	115	NM
40	36	**Yamaha**	1,465	5	3,856	1	142	12
41	30	**Yokogawa Electric***	1,419	6	1,981	6	75	37
42	40	**Honda**	1,387	1	33,022	2	1,153	4
43	42	**Clarion**	1,352	NM	1,388	NM	-19	NM
44	45	**Mitsumi Electric**	1,343	13	1,343	13	66	35
45	43	**Shimadzu**	1,290	2	1,466	2	83	0
46	39	**Fanuc***	1,203	-18	1,203	-18	293	-43
47	–	**Daewoo Electronics**	1,183	20	2,151	20	173	23
48	–	**Samsung Electronic Devices**	1,140	18	1,140	18	83	2
49	46	**Sanshin Electronics**	1,118	1	1,118	1	32	-18
50	44	**Shin-Etsu Chemical**	1,076	3	3,597	2	343	-9

NA = not available
NM = not meaningful

* Preliminary estimate before final figures available.

** Figures for Seiko Corp. only. Does not include sales of separate, privately held affiliates, Seiko Epson and Seiko Instruments.

Operating income as % of sales	Net income ($ millions)	% change (90/91)	Net income as % of sales	Return on equity	Return on investment	Debt as a percentage of total capital	Foreign sales as a percentage of total sales	Fiscal year ended
5.2%	$999	-49	1.8%	3.8%	2.1%	44.0%	48%	3/92
3.2%	115	-72	0.4%	1.7%	1.7%	NA	21%	3/92
2.5%	297	-67	0.8%	3.3%	3.3%	NA	29%	3/92
3.8%	92	-85	0.4%	NA	NA	NA	30%	3/92
4.5%	959	-45	1.6%	4.4%	4.4%	NA	24%	3/92
4.4%	903	3	3.1%	7.8%	3.9%	49.7%	75%	3/92
8.9%	1,436	-19	3.0%	4.5%	2.3%	48.0%	NA	3/92
7.4%	392	-15	2.8%	7.8%	3.7%	52.5%	69%	12/91
4.4%	271	-55	1.1%	4.4%	4.4%	NA	21%	3/92
4.0%	294	-17	2.5%	NA	NA	NA	50%	3/92
12.7%	94	-5	1.3%	NA	NA	NA	58%	12/91
1.1%	15	-85	0.2%	NA	NA	NA	NA	3/92
3.1%	127	-4	1.1%	2.3%	1.2%	47.1%	41%	11/91
1.5%	-4	NM	-0.1%	-0.3%	-0.1%	69.6%	30%	3/92
9.2%	25	-45	0.5%	NA	NA	NA	51%	12/91
9.4%	214	-17	4.6%	8.6%	8.6%	NA	59%	3/92
26.3%	655	26	15.5%	NA	NA	NA	NA	3/92
10.1%	162	-24	4.0%	5.6%	4.2%	24.6%	51%	3/92
5.2%	46	-71	1.3%	NA	NA	NA	21%	3/92
4.1%	55	-12	1.6%	NA	NA	NA	NA	3/92
4.4%	457	-4	4.1%	8.3%	6.0%	27.4%	21%	12/91
5.1%	3,244	-2	4.4%	NA	NA	NA	NA	6/91
9.3%	204	-16	6.0%	5.3%	4.8%	9.6%	53%	3/92
5.5%	79	15	2.7%	6.6%	3.1%	53.4%	60%	3/92
6.9%	105	-19	3.4%	8.7%	8.7%	NA	NA	3/92
3.7%	-17	NM	-0.5%	NA	NA	NA	NA	3/92
-1.0%	-271	NM	-10.1%	-51.2%	-24.6%	51.9%	78%	3/92
15.9%	204	8	9.7%	8.4%	7.1%	16.2%	43%	3/92
4.6%	126	-24	1.8%	9.4%	9.4%	NA	9%	3/92
2.3%	762	107	1.6%	NA	NA	NA	NA	3/92
3.7%	15	-10	0.9%	3.6%	1.5%	58.1%	68%	3/92
3.6%	33	4	1.9%	6.7%	4.4%	33.8%	5%	9/91
4.6%	11	45	0.3%	NA	NA	NA	NA	4/92
7.1%	44	-20	2.7%	7.2%	3.5%	51.3%	25%	3/92
4.8%	40	-69	2.0%	3.4%	1.9%	44.5%	54%	3/92
5.3%	38	-31	2.0%	NA	NA	NA	NA	3/92
11.2%	55	36	3.6%	4.2%	2.8%	32.1%	33%	3/92
8.7%	262	5	3.2%	8.0%	4.4%	45.4%	6%	11/91
7.8%	63	NM	4.2%	5.8%	5.8%	NA	NA	3/92
3.7%	43	-25	1.1%	3.5%	2.1%	40.2%	37%	3/92
3.8%	56	0	2.8%	NA	NA	NA	NA	3/92
3.5%	488	-15	1.5%	5.9%	2.9%	51.4%	68%	3/92
-1.3%	-43	NM	-3.1%	-10.6%	-4.5%	57.4%	32%	3/92
4.9%	22	90	1.6%	10.9%	4.2%	61.3%	44%	1/92
5.6%	44	-5	3.0%	NA	NA	NA	NA	3/92
24.4%	227	-25	18.9%	NA	NA	NA	NA	3/92
8.0%	19	6	0.9%	NA	NA	NA	64%	12/91
7.3%	36	-14	3.2%	NA	NA	NA	88%	12/91
2.8%	9	-21	0.8%	5.0%	2.2%	56.1%	6%	9/91
9.5%	185	-7	5.1%	10.1%	5.9%	41.6%	27%	3/92

All figures are consolidated.

Percentage change is calculated in local currency.

$1=133 Japanese yen, 733 Korean won. Those companies whose fiscal years ended other than March 1992 may use different rates in their own reporting.

Source: ELECTRONIC BUSINESS

EDITORIAL STAFF

Publisher: Frank J. Burge
Editorial Director: Lewis H. Young
Editor: John Russell
Managing Editor: H. Garrett DeYoung
Senior Editors: Linda Stallmann (Financial), Rick Whiting, Elizabeth B. Baatz, Peter L. Burrows
Associate Editor: David Webb (San Jose)
Assistant Editor: Barbara Jorgensen
Copy Editor: Elaine M. Cummings
Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Paula Doe (Japan), John Farrell (Cahners Economics), Tom McHale, Joel McCormick
Correspondents: Geoff Crane (Seoul), Craig Addison (Hong Kong)
Consulting Editor: Alberto Socolovsky
Senior Production Editor: Karen J. Covey
Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach
Associate Art Director: Martha Abdella

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: David Webb
Sherman Building, 3031 Tisch Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing: John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Manager: Joshua Levin-Epstein

CIRCULATION

Circulation Manager: Ken Evans
44 Cook Street, Denver, CO 80206
(303) 388-4511
Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices.
Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

VIEWPOINT

Are we falling out of love with TQM?

IS U.S. INDUSTRY falling out of love with quality improvement programs? Let's hope not. Now would be the worst of all times to be fickle. For one thing, U.S. industry's reputation for producing high-quality products has just started to rebound. For another, too many companies aren't yet aggressively seeking to improve quality. These folks need to smarten up.

There is even some grumbling that legendary Japanese quality is slipping as a result of the sudden financial pressure on Japan's electronics industry. Before you laugh at that, consider that Matsushita reported its pretax profit fell 62% for the quarter ended last June; and its consumer subsidiary, JVC, announced it would cut 3,000 workers as a result. Sony and Toshiba are feeling the same pressure.

The truth is that the U.S. is making substantial progress in improving the quality of U.S. goods *and* organizations. To slow that progress now by reducing our commitment to total quality management (TQM) programs would be a colossal mistake.

Two of the biggest lightning rods for critics of U.S. quality improvement efforts are the Malcolm Baldrige National Quality Award and the absence of a clear financial return on quality. No doubt, some of the Baldrige criticism is justified. It's not necessarily a flop as an award, but it's not a grand success, either. Indeed, "picking winners" may not always be a good idea, although doing so is a good match with the U.S.'s competitive ethos. What is clear, however, is that Baldrige Award criteria comprise an excellent tool for improving quality. Roughly 50,000 Baldrige applications have been distributed to companies, and about 10,000 TQM presentations have been given to companies by Baldrige examiners and winners.

The second big problem is the need for the top brass to see clear bottom-line payoffs from TQM—a worthy task, but one that's difficult to accomplish. It's relatively easy to show cost savings from reduced scrap and the like. It's much harder to directly link increased sales, improved profits, or increased market share to ongoing quality efforts. For these reasons, too many companies aggressively pursue early TQM efforts but then slack off because they can't quantify the continued payback.

Let's not be deflected by these and other concerns. The biggest reason to continue to embrace the quality revolution is that it works. It's the only way to succeed in today's global market. Let's not mess up.

—John Russell, editor

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published monthly by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President/Chief Operating Officer; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address changes to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.**
ELECTRONIC BUSINESS® copyright 1992 by Reed Publishing USA; Robert L. Krakoff, President and Chief Executive Officer.
Annual subscription rates for non-qualified people: USA, $64.95; Mexico, $89.95; Canada, $96.25; other countries, $119.95 per year, $48.00, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $8.00 USA and $11.00 foreign. Please address all subscription mail to Ken Evans, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Media • Home Furnishings • Interior Design • Lodging. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

BPA ABP